POWER

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Engineers' Week

THIS is Engineers' Week in New York.

The American Society of Mechanical Engineers, approaching its half century of existence, is holding its Forty-eighth Annual Meeting.

The younger but vigorous American Society of Refrigerating Engineers is holding its annual meeting contemporaneously and in some respects jointly with the A.S.M.E.

The Power Show displays those accouterments by which the power that makes possible modern industry and engineering is generated.

These societies are in continual operation. This week is but an episode in their annual round.

All through the year committees are grinding upon problems of research and standardization, and safety and management, and improvement of materials and methods and their better adaptation to the purposes of man.

All through the year inventors are conceiving ideas and consolidating them into forms that will serve new purposes or better fulfill the old.

This is the time that the achievements are held up to view, results proclaimed, propositions discussed, progress reported and the public invited to look on.

Of this the general public takes little heed. It is the engineer's week, and only he appreciates its significance.

But this week and every week the public sees with unseeing eyes and is served, with but a fitful impression of it, by the work of the engineer.

The buildings that line the streets, the shipping upon the river, the transportation systems, the streets themselves, with their subterranean systems of water and gas and steam mains and electric conduits and sewers, all cry credit to the engineer.

It is pleasing to notice that in the completion of the vehicular tunnel just opened between New York and New Jersey, an unwonted recognition of the part that engineers have played in its construction was made by naming the tubes themselves for Holland and the plaza at the New York approach for Milton H. Freeman, two engineers who died in the service of its construction.

Lowering the Fuel Cost *at the* Capitol Power Plant*

How an Expenditure of $201,000 in New Equipment Netted an Annual Saving of $77,700

By J. F. Barkley

Fuel Engineer, United States Bureau of Mines

THE main equipment of the Capitol power plant consists of sixteen 5,710-sq.ft. stoker-fired boilers and four 2,000-kw. 25-cycle 6,600-volt turbine-generators. The load is made up of a steam demand for heating, cooking, certain processing, etc., and an electric demand for light and power. Changes in arrangement and in certain items of the plant equipment have reduced the yearly fuel expense about $70,000. When the present program of changes is completed and the contemplated increased load on the plant is assumed, the savings in yearly fuel cost will total about $100,000. The detailed explanation of these changes and the results follows.

In the original arrangement of plant equipment the steam turbines exhausted to barometric condensers which were supplied with raw river water and which emptied into a hotwell. The exhaust from certain auxiliaries, such as stoker engines and boiler feed pumps, was also piped to the hotwell, adding further heat to this water. The boilers were fed directly from the hotwell, its excess water discharging back into the river. The temperature of the boiler feed water averaged about 85 deg. F. The condensate of the steam used for heating the widely scattered buildings was wasted to the sewer.

There was first installed a feed water treating system consisting of a settling tank, filter tank and softener. Next a feed-water heater was installed and piped to receive the exhaust from the plant auxiliaries as well as returns from the steam traps and power plant heating system. This raised the feed water temperature to about 135 deg. F. These changes effected a saving of approximately six per cent of the coal that would have been used under the old conditions, owing to the higher feed water temperature, increased efficiency of the boilers because of clean tubes, and the reduction of the blowdown necessary for proper boiler operating conditions. At that time the yearly coal cost was approximately $220,000, six per cent of which is $13,200.

In addition to this saving there was a greatly lessened cost of boiler maintenance. Under the old arrangement it was necessary to replace about 290 boiler tubes a year and to take a boiler off the line after twenty days

*This contribution received honorable mention by the judges in the recent *Power* Prize Contest.

for cleaning. With the treated feed water no tubes to date (a period of some two years) have been replaced, and a boiler is taken off the line after ninety days, principally for inspection, as no harmful scale has been precipitated. This saving is approximately $3,000 a year in materials alone. The cost of making these feed water changes was about $37,000, and the yearly cost of treating the water was $1,950.

The next major change was the replacement of eight of the overfeed natural-draft stokers that formed part of the old installation, with underfeed forced-draft stokers. These were of the five-retort, 21-tuyere type. At the same time the style of baffling of the eight boilers was changed. This is shown in Figs. 1 and 2. Owing to structural limitations of the old setting, a strictly ideal arrangement of stoker setting and combustion chamber could not be obtained. Back of the carborundum brick of the furnace, shown in Fig. 2, air was circulated from the pressure side of the forced-draft fan. It was returned by duct to the suction side of the fan to mix with the main supply coming from the space just above the boilers. This cooled the brickwork, lowered the radiation and preheated somewhat the air for combustion.

In the drive during recent years for fuel economy in power plant practice throughout the country, the United States government has been participating not only in an advisory capacity, but also in a direct operative capacity with regard to the many government power plants under its jurisdiction. One of the outstanding plants to date that has effected lowered costs, is that supplying heat, light and power to the Capitol, the Senate and House Office Buildings, the Government Printing Office, and other buildings on or near-by Capitol Hill at Washington.

Results as Shown by Tests

The results of tests of the boiler with each of these types of stokers are given in the table. A boiler efficiency of 69.2 per cent was obtained when using the old overfeed stoker. The test was run under the usual operating conditions and is fairly representative. Although without superheater or economizer, an efficiency of 82.4 per cent at about boiler rating and of 77.3 per cent at about double boiler rating was obtained with the new underfeed stoker. These high efficiencies were obtained on acceptance tests run with much care by a personnel of expert engineers. A satisfactory heat balance resulted, and it is believed that the efficiencies are representative for the conditions. Later tests under the usual operating conditions showed an average of about 79 per cent efficiency; $\frac{69.2}{79.0} = 87.6$ per cent, or a saving of 12.4 per cent of the coal, say 10 per cent as an average.

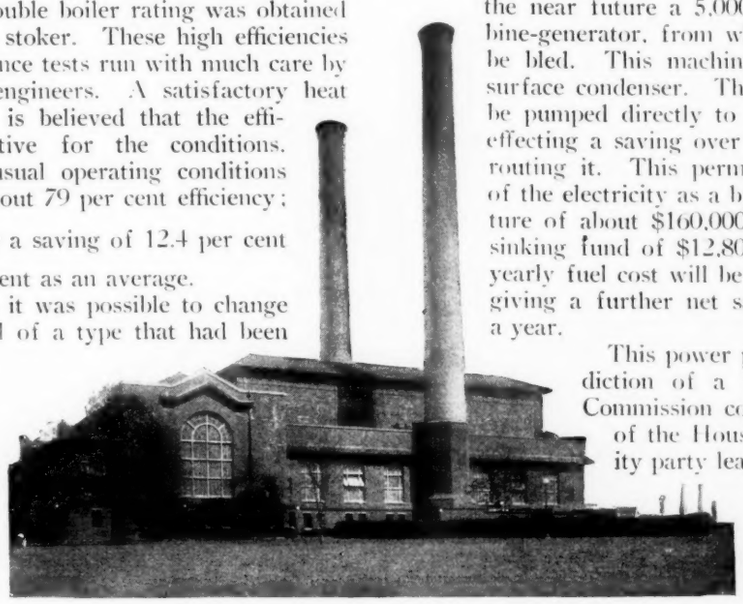
With the new stokers it was possible to change from a run-of-mine coal of a type that had been used there for years, to a cheaper slack coal of about the same calorific value. Had the usual run-of-mine coal been used, its cost to the plant from the bid price would have been $5.31 a ton. The cost of the slack coal from the bid price was $4.36, or $0.95 a ton cheaper. There was being used just previously to this change about 42,000 tons of coal per year; 42,000 × $5.31 = $223,000; 42,000 × 90 per cent × $4.36 = $164,808; difference = $58,212 a year. To this might also be added a small saving arising from lessened coal crushing costs. These changes cost about $120,000.

There was next installed a pipe line to return to the feed-water heater the condensate of the steam used for heating the Capitol, Library, House Office and Senate Office Buildings. The boiler feed water is now heated to about 200 deg. F. with the exhaust steam from the auxiliaries, etc. This change made a saving of fuel cost estimated at about $6,300 a year. It also made a saving of some $500 a year in the cost of treating the feed water, as it is unnecessary to treat this returned condensate. The cost of this pipe line was $44,000.

Net Yearly Savings

Summarizing, an expenditure of $201,000 made possible an annual saving in fuel cost of $77,700. A yearly sinking fund of $16,080, at 4 per cent interest, would retire this item in a little less than twenty years, leaving a net yearly saving of $61,620. The plant expenditures for the last year show that these estimated savings are more than being realized through the attentive efforts of the operating crew.

Further studies on the heat balance of the plant are in progress. As a result of a study made to determine the proper method of effecting savings of fuel on the electrical side of the plant, it was decided to install in the near future a 5,000-kw. bleeder type turbine-generator, from which heating steam can be bled. This machine will be served by a surface condenser. The condensed steam will be pumped directly to the feed water heater, effecting a saving over the present method of routing it. This permits of producing much of the electricity as a byproduct. An expenditure of about $160,000 will be required, or a sinking fund of $12,800 a year. The present yearly fuel cost will be reduced about $30,000, giving a further net saving of about $17,200 a year.



Exterior view of Capitol power plant

This power plant is under the jurisdiction of a House Office Building Commission composed of the Speaker of the House, chairman, the minority party leader of the House, and a member of the majority party, the personnel now being the Honorables Nicholas Longworth, F. J. Garrett and I. Bacharach.

The commission is represented by David Lynn, architect of the Capitol, who is in full administrative charge of such matters. The direct management of the power plant is under R. L. Harrison, chief engineer, during whose superintendency the foregoing changes have been carried out.

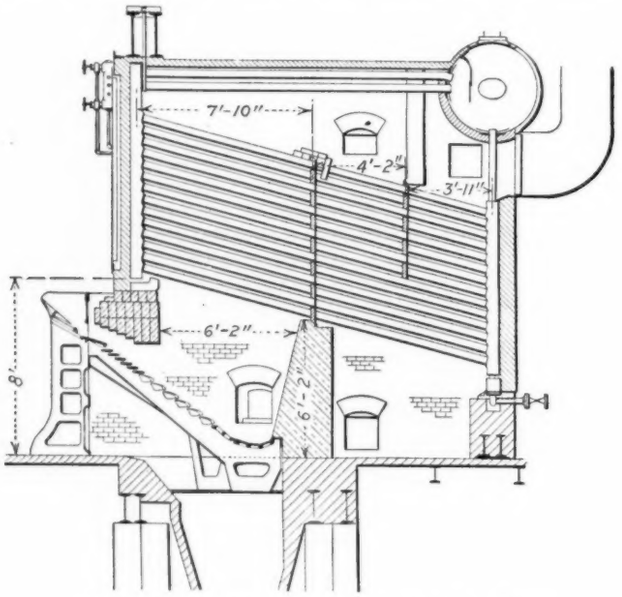


Fig. 1—Arrangement of the original stoker and boiler baffles

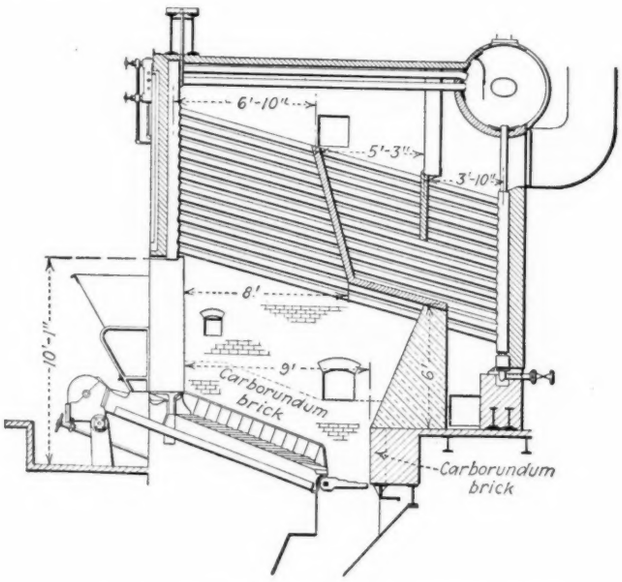


Fig. 2—Arrangement of the present stoker and boiler baffles

RESULTS OF BOILER TESTS

Test number	1	2	3
Date	4-16-17-25	5-13-11-26	5-11-12-26
Duration, hr	23.43	24.10	16.42
Boiler No	6	6	6
Type of boiler	Cross drum	Cross drum	Cross drum
Type of stoker	Overfeed	Underfeed	Underfeed
Grate surface, projected, sq.ft	93	81	81
Type of fuel	Semi-bitum. coal	Semi-bitum. coal	Semi-bitum. coal
Boiler heating surface, sq. ft.	5,710	5,710	5,710
Ratio of heating surface to grate surface	61.4	70.5	70.5
Combustion space volume (approx.) cu.ft	480	910	910
Average Pressures and Temperatures:			
Steam pressure by gage, lb. sq.in	188.9	185.7	177.7
Force of draft—combus. chamber, in. water	0.498	0.026	0.033
Force of draft—boiler breeching ahead of damper, in. water	0.820	.....	0.411
Pressure of air at stoker tuyeres, in. water	.....	2.10	5.68
Pressure of air under dump plate, in. water	.....	1.17	4.58
Temperature of feed water entering boiler, deg. F	58.3	65.3	65.2
Temperature of calorimeter, deg. F	305.1	304.6	305.3
Temperature of escaping gases leaving boiler, deg. F	535	440	572
Temperature of boiler room, deg. F	66.1	96.9	92.0
Temperature of air in wind box, deg. F	.....	108.9	108.4
Quality of Steam:			
Percentage of moisture in steam	0.499	0.501	0.377
Factor of correction for quality of steam	0.99642	0.99638	0.99726
Hourly Quantities and Rates:			
Dry coal per hour, lb	2,296	1,696	3,565
Dry coal per sq.ft. of grate surface per hr., lb	24.7	20.9	44.0
Water evaporated per hr. corrected for quality of steam, lb	19,428	16,999	33,662
Equivalent evaporation from and at 212 deg. per hr., lb	23,464	20,405	40,384
Equivalent evaporation from and at 212 deg. per hr. per sq.ft. of boiler heating surface, lb	4.11	3.57	7.07
Capacity:			
Percentage of rated cap. developed, per cent	119.1	103.6	205.0

Economy:			
Water fed per lb. of coal as fired, lb	8.36	9.79	9.21
Water evaporated per lb. of dry coal, lb	8.46	10.03	9.44
Units of evaporation per lb. of coal as fired (1,000 B.t.u.) lb	10.06	11.71	11.02
Units of evaporation per lb. of dry coal, lb	10.22	12.03	11.33
Analysis of dry gases by volume:			
a. Carbon dioxide (CO_2), per cent	8.76	14.17	13.31
b. Oxygen (O_2), per cent	10.68	4.54	5.45
c. Carbon monoxide (CO), per cent	0.06	0.08	0.03
d. Nitrogen (N_2) by difference, per cent	80.50	81.21	81.21
Lb. dry flue gases per lb. carbon, lb	28.18	17.81	18.96
Lb. dry flue gases per lb. dry coal, lb	21.48	14.19	14.71
Proximate Analysis of Coal as Fired:			
a. Moisture, per cent	1.6	2.7	2.7
b. Volatile matter, per cent	20.9	27.4	28.2
c. Fixed carbon, per cent	69.9	61.9	61.4
d. Ash, per cent	7.6	8.0	7.7
Ultimate Analysis of Dry Coal:			
a. Carbon (C), per cent	81.1	80.7	80.6
b. Hydrogen (H_2), per cent	4.6	4.8	4.7
c. Oxygen (O_2), per cent	3.4	3.9	4.4
d. Nitrogen (N_2), per cent	1.4	1.5	1.5
e. Sulphur (S), per cent	1.8	0.9	0.9
f. Ash, per cent	7.7	8.2	7.9
B.t.u. per lb. of dry coal, b.t.u.	14,320	14,180	14,220
Analysis of Dry Ash and Refuse:			
a. Combustible, per cent	49.1	12.9	27.7
b. Ash, per cent	50.9	87.1	72.3

Heat Balance, Based on Dry Coal:	B.t.u.	Per Cent	B.t.u.	Per Cent	B.t.u.	Per Cent
a. Heat absorbed by boiler	9,916	69.2	11,677	82.4	10,994	77.3
b. Loss due to heat carried away by steam in flue gases	545	3.8	549	3.9	568	4.0
c. Loss due to heat carried away by dry flue gases	2,418	16.9	1,168	8.2	1,695	11.9
d. Loss due to carbon monoxide	53	0.4	45	0.3	18	0.1
e. Loss due to combustible in ash and refuse	714	5.0	151	1.1	438	3.1
f. Loss due to unconsumed hydrogen, hydrocarbons to radiation and unaccounted for	674	4.7	590	4.1	507	3.6

Rational Boiler Plant Design for Low Cost Steam*

By F. A. Combe

IN AN aim for high thermal efficiency and rating, has there been a tendency to overburden beyond the economic limit the cost of industrial boiler plants constructed recently?

Does the saving in fuel consumption which is undoubtedly shown by the recent remodeling of some boiler plants represent a real gain as regards net cost of steam delivered from the boiler house, including all fixed, operating and incidental charges, over the result that might have been effected from a less costly and possibly less efficient arrangement?

These are pertinent questions that are being asked today, and to the first it would appear that the answer must be in the affirmative, and what the answer to the second should be is very doubtful in many cases.

Competing With Record Performances

There is a strong temptation to try to emulate the published performances of the large modern steam-electric generating stations, and at times this is done without proper appreciation of the difference in conditions to be met.

Probably responsibility also lies in the developments that are taking place in furnace designs, particularly for pulverized fuel, and the arrangement of heat absorbing surfaces to meet modern conditions of high steam pressures. These developments are taking place so rapidly, that plants are often obsolete before they are completed. Fixed charges have been rising steadily on central stations built during recent years, and the effort of designers of such stations is now largely directed toward simplification and reduction in cost.

It is not necessary, nor is it advisable, for the industrial plant to adopt practices and special designs developed to meet central station conditions. There are, however, great opportunities today to produce a plant low in first cost, in operation and in maintenance, that will deliver steam at as low a net figure, including all investment and carrying charges, as the large central stations.

Fixed Charges Must Be Carried in Cost per Thousand Pounds of Steam

Fixed charges, including interest, depreciation, obsolescence, taxes and overhead, must be carried in the cost per thousand pounds of steam delivered from the boiler plant. Obviously, these charges will be three times as much per thousand pounds of steam for a plant operating on an eight-hour working day or, say, a 30 per cent monthly load factor, as for a plant operating twenty-four hours a day with a monthly load factor of around 90 per cent. Take for example, a plant on a twenty-four hour load producing steam for fifty cents a thousand pounds, including fuel cost, operating costs and fixed charges, and of which the fuel cost is thirty cents and fixed charges five cents. If the plant operated on an eight-hour load at the same efficiency, the fixed charges will be three times as great as before, or will amount to fifteen cents per thousand pounds steam. It is, therefore, necessary to balance carefully the expenditures on a plant with the possible improvement in efficiency.

Obsolescence is a factor that should be taken into consideration in the question of remodeling for a sound commercial undertaking. How is the discarded equipment to be written off? If it has been in service for less than fifteen or twenty years, it will probably have to be carried by the new installation. A short time ago I visited a boiler plant that had been built originally less than ten years ago to burn a certain fuel. Recently, it was entirely rebuilt to burn another fuel, with a very up-to-date and expensive installation. If all charges were included, this new plant would have to operate at over 90 per cent efficiency in order to justify itself. Needless to say, it falls far short of that.

I do not wish to give the impression that I am discouraging remodeling, but to point out that our natural desires as engineers to use the latest developments and to get the highest efficiencies must be tempered with proper regard to the commercial aspects. It is a comparatively easy matter to design a plant for high efficiency, but it is not always so easy to strike the right balance. More particularly is this the case with industrial plants, with which there are not the same possibilities for absorbing overhead and fixed charges as with public service stations.

Why Is an Elaborate Plant Necessary?

Frequently, we hear of a comparatively small industrial plant, with simple but well proportioned equipment giving a thermal efficiency approximately equal to that of the modern central station and with considerably lower fixed charges and proportionate running expenses.

Why, then, one may naturally ask, the necessity for the elaborate plant?

When the rate of fuel burning is increased beyond a certain point, in a standard boiler with brick-lined furnaces, the high temperature and erosion tend to cause the brickwork to fail quickly. This can be prevented in the case of stoker furnaces, within the limits of economical operation, if there is an opportunity to obtain suitable proportioning of the boiler, furnace and grate and proper inclination and construction of furnace walls.

To overcome side-wall trouble, particularly with pulverized fuel, additional boiler tubes have been introduced around the furnace as a protection to the brick-

* Paper presented at Steel & Power Show Technical Session, Engineering Institute of Canada, Toronto, August 31, 1927.

work. These tubes increase the evaporative capacity of the boiler, since they form the most effective surface, and permit higher rates of combustion in the furnace without danger from brickwork failure. To meet the requirements for satisfactory operation of these furnace tubes and conditions arising from high rates of operation, additional auxiliary equipment often becomes necessary, leading to further complications. These are justified in large steam stations, but one must not lose proper sense of perspective in values when considering moderate-sized plants for industrial use with outputs of less than 100,000 lb. steam an hour. In such plants the cost of furnace-wall tubes plus auxiliaries will frequently amount to more than the cost of installing an additional unit and may not prove so satisfactory.

High Rating Not Always Economical

Operating at so-called high rating is not necessarily economical. The value of high concentration of steam production per square foot of ground area depends upon

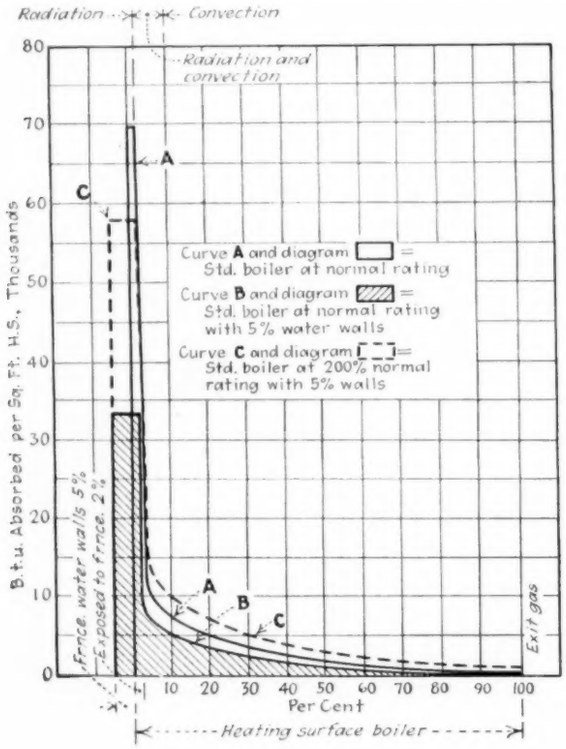

Radiation
Convection
Radiation and convection
A
C
Curve A and diagram = Std. boiler at normal rating
Curve B and diagram = Std. boiler at normal rating with 5% water walls
Curve C and diagram = Std. boiler at 200% normal rating with 5% walls
B.t.u. Absorbed per Sq. Ft. H.S., Thousands
Furnace water walls 5%
Exposed to Furnace, 2%
Exit gas
Per Cent
Heating surface boiler

Fig. 1—Typical heat-absorbing curves of water-tube boilers

the relative value of the real estate and the cost of building, which is usually quite different for industrial plants and large central stations. The cost of high boiler houses with heavy supporting structures becomes proportionately greater as the plant decreases in size. It may be that the additional auxiliary equipment necessary in the concentrated plant will take up much of the space saved by the high-capacity units without providing the same reserve, and such reserve is usually important. Load conditions and the load factor have an important influence on the plant design and upon the rate of operation.

The development of water-tube walled furnaces with the standard forms of boilers gives cause for feeling that the art of steam generation has reached a state that calls for radical modification in boiler design, especially in the smaller units, if higher rates of operation are to come into general use. The composite arrangement of a water-tube walled furnace, a standard boiler, an independent economizer or water-heating section and an air preheater, has a flexibility that can be used to advantage by an experienced designer, but the proportionate cost becomes very high when applied to plants of moderate or small capacity. There is a need for more inclusive designs incorporating the features that have proved most economical and desirable.

Future boiler designs will no doubt include heating surface entirely surrounding the furnace, with the introduction of a refractory lining to the extent that may be required for the combustion of particular fuels and load conditions. The portion of the boiler heating surface exposed to the direct heat from the furnace will logically form the evaporating section, and the balance proportioned for the efficient transfer of heat by convection, and sectionalized to obtain full benefit from the heat gradient and temperature difference between gases and water. Heat in the gases leaving the water section will be utilized to raise the temperature of the air for combustion. In the smaller units the whole will be probably incased in one setting. The separation of the circulation systems becomes of particular importance when high steam pressures are carried, as under such conditions the value of the rear sections of the boiler with single circulation becomes particularly uneconomical.

When the component parts of the heat-absorbing surface of a steam generating set are supplied by different manufacturers without co-operation, or when a large amount of furnace water-wall surface is added to a standard boiler, there is a danger in the possible effect it may have on the circulation in the boiler unless properly provided for. An additional danger exists in the increased burden put on the liberating surface and steam space in the boiler drum, which was designed to take care of the heating surface of the boiler only.

Curves of Performance

Typical curves of the performance of a standard water-tube boiler, with and without water-wall tubes in the furnace, to show the effect on absorption of heat throughout the unit are shown in Fig. 1. The water-tube boiler in its various forms in common use today is necessarily a very unbalanced machine with respect to the duty performed by its different parts. As the gases enter the bank of tubes, they are cooled and in passing through the boiler transfer heat by convection at a rate practically proportional to the actual difference of temperature between gases and tubes.

Curve *A* shows the heat absorption per square foot of boiler heating surface exposed to the furnace and along the path of gas travel, for a certain normal rate of operation. Of the heating surface 2 per cent is exposed to direct radiation from the furnace and absorbs heat at a rate of around 70,000 B.t.u. per square foot per hour. As the gases pass along the surface, their temperature drops rapidly and the heat absorption is reduced until at the exit the rate is in the neighborhood of 600 B.t.u. The diagram bounded by this curve *A* indicates the work done by the boiler, and it will be seen that the surface exposed to the furnace is doing nearly 120 times as much

work as the surface at the gas exit end, or is operating at 1,800 per cent of the average rate. This difference in the rate of absorption is reflected in the financial value of one square foot of heating surface.

Curve *B* and the sectioned diagram show the effect of adding another 5 per cent of the boiler heating surface in the form of water tubes in the furnace. These tubes will absorb heat at approximately the same rate as

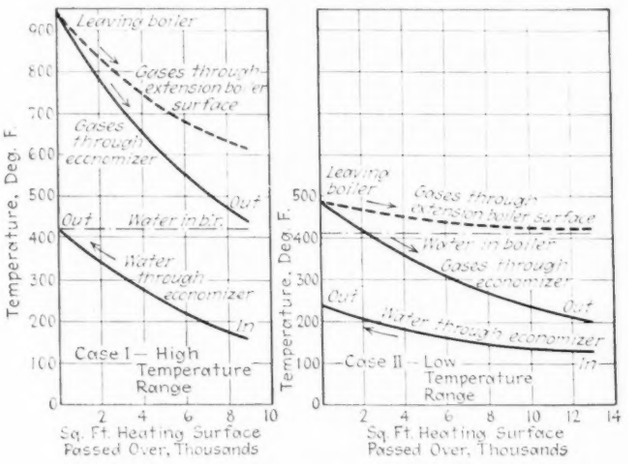


Fig. 2—Reduction in gas temperature in passing through a boiler

the regular boiler tubes exposed to radiation, but with the same amount of coal burned as before, the furnace temperature will be reduced, owing to the increased cooling surface exposed. This results in a lower heat absorption per square foot throughout the boiler and makes the last tubes still more uneconomical.

If more fuel be burned in the furnace and water-wall tubes be used to double the output, the intensity of absorption in the tubes exposed to the furnace will still be less than at normal load without water walls, as shown by curve *C* and the dotted diagram. Owing to the greater weight of gases passing over the heating surface, the rate of heat absorption will be increased, but the exit temperature will be higher and the efficiency of the boiler itself lower, but not to the same degree as an equal load without water walls.

Load Rate of Boilers

Little meaning is conveyed by the term "load rate of a boiler," unless the proportions and arrangement of the heating surface are known. Boilers reported enthusiastically as operating at 300 per cent rating may not be operating at higher intensive rates than others at 100 or 150 per cent rating, and possibly cannot be operated economically at less than 125 per cent rating owing to furnace chilling.

When boilers are operated at higher rates or under higher steam pressures, the temperature of the gases leaving the boiler is greater, resulting in a decrease of efficiency. In the case of high rating this increased temperature results from the greater weight of gases passing over the heating surface, and in the case of higher steam pressure is due to the increased temperature of the heating surface and consequently the smaller difference of temperature between gases and heating surface.

In order to indicate the value of separating the water heating section from the circulation system of a steam generating unit, by taking advantage of the greater temperature differential and of high-efficiency heat-absorbing surface, a series of curves calculated from actual boiler plant performances representing extreme cases have been made up.

In Fig. 2 the curves show the reduction in temperature of the flue gases leaving the boiler proper and passing over the counterflow economizer section as installed in these particular plants, compared with the reduction that would have resulted if an equal area had been added to the boiler heating surface. Case 1 is taken from an installation where the surface of the boiler was comparatively small, the gases leaving at 970 deg. under the load carried at the time. Corresponding curves for an installation in which a large economizer was used in conjunction with a standard boiler from which the gases left at a temperature of 420 deg. under the load carried are shown in case 2. Curves are also given of the rise in temperature of the water through the economizers, which in case 1 was brought up to the temperature in the boiler. The water temperature entering the economizer section was approximately the same in each case and comparatively low.

In Fig. 3 the curves show the heat absorption per equare foot, or work done, by the economizer and supposed boiler heating surface corresponding to the temperature curves in Fig. 2. From these it will be seen that in case 1 the absorption value of a square foot of economizer surface was about 20 per cent greater at the point of gas entry than it would have been by an extension to the boiler heating surface, and 70 per cent greater at the exit end. In case 2 the absorption per square foot by the economizer heating surface was nearly four times

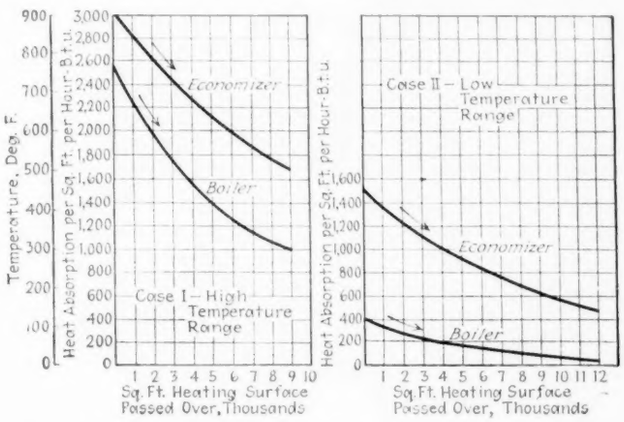

Temperature, Deg. F.
Heat Absorption per Sq. Ft. per Hour-B.t.u.
Economizer
Boiler
Case I — High Temperature Range
Sq. Ft. Heating Surface Passed Over, Thousands
Heat Absorption per Sq. Ft. per Hour-B.t.u.
Case II — Low Temperature Range
Economizer
Boiler
Sq. Ft. Heating Surface Passed Over, Thousands

Fig. 3—Heat absorption of the economizer and boiler

as great as an extension to the boiler heating surface at the gas inlet and eight times as great at the gas exit.

Between these cases lies the range in which the value of an economizer or separate water heating section is usually to be considered. The actual proportioning of surface will depend upon the temperature of feed water, the steam pressure, and the load conditions, and these must be studied in conjunction with investment and operating costs.

Where the temperature of the feed water is over 200 deg. or in cases where the water can be heated to advantage by steam bled from turbines, it may be more profitable to utilize available heat from the flue gases to preheat

air to the furnace, or to use a combination of economizer and air preheater. In case 1 such a combination was used, the gases later passing through a preheater and being reduced in temperature to 200 deg. F. under the conditions shown.

The point to be emphasized is the value of getting all possible heat out of the flue gases. Effort is often concentrated on obtaining the additional fraction of combustion efficiency in the furnace, which after all depends to a large degree upon the skill of operation, to the neglect of heat loss in the flue gases.

It is frequently the case in industrial plants that the installation of economizers or air preheaters cannot be justified for the boiler plant, but that heat from the flue gases can be utilized for some other purpose connected with the mill or factory. The most profitable use of such heat must be determined by an independent engineering study of the operating and manufacturing conditions from the viewpoint of the owner's best interests.

Unfortunately, it has been quite common practice to purchase the boilers first and then to consider what method of fuel burning should be used. It may then have been found that the boiler furnace limitations have prevented the installation of fuel-burning equipment of the best proportions or, in an endeavor to keep down first cost, high rates of combustion have been decided upon.

This has led to the consideration of water-cooled walls or has resulted in excessive maintenance costs. Water walls in such cases are used to overcome a condition that could never have existed under proper co-ordinated design. Then the question of the advisability of an economizer is taken up, with, possibly, the comparative advantage of an air preheater. An analysis of such plants would show that much money could have been saved and better results obtained by a study of the design as a whole based on the particular conditions of service.

IN A GRAVITY RETURN SYSTEM the difference in level between the normal water level in the boiler and the lowest point of the overhead return line is sometimes referred to as "static head," and is the head of water that ordinarily returns condensation to the boiler. If the static head at any time becomes insufficient to return the condensation, a low water condition may result, with consequent cracking of boiler sections. There are several conditions that may arise to cause the static head to be insufficient to return the water, and these may be summarized as either a rise of pressure in the boiler, or a reduction of pressure in the return line. To overcome the possibility of an excessive pressure difference preventing the return of water, there are available special traps designed to return the condensation. These traps contain a float which controls two valves within the trap, one for the steam supply from the boiler and one for the return line from the system. Assuming that the float is down, the steam supply valve will be closed and the valve from the return line open. The condensation then flows by gravity into the trap. As water accumulates, the float rises until it closes the valve in the return line and opens the valve in the steam line, thus imposing boiler pressure on the water in the trap. This allows it to flow by gravity into the boiler. When the trap has emptied, the float reverses the valve positions and permits the trap to fill with another charge of condensation. Return traps should be installed at such a height that positive return of water to the boiler is insured.

What Do You Know?

BY L. H. MORRISON

The answers are on page 898

A MAN recently committed suicide because he discovered he was getting bald at the back of his head. If he had spent as much thought on the contents as he did on the covering of his head, he would have arrived at a sounder philosophy. It is the stuff within your head that counts. Have you ever attempted to triangulate your gray matter? Just what has formed the convolutions of your brain? Has it been smoking-car jokes, the high-jinks of actresses or engineering data? If it has been engineering, you should be able to answer these ten questions. The editor gives answers which he feels are correct, on another page.

Ques. 1—Why is a bent rocker used on many high-speed steam engines for operating the valve gear?

Ques. 2—What will be the effect in the operation of an engine if the eccentric is turned off $\frac{1}{4}$ in. in its diameter and a new eccentric strap made to fit the new diameter?

Ques. 3—What would you expect the exhaust-gas temperature of a two-stroke-cycle Diesel to be on full load?

Ques. 4—An engineer has stated that no improvement in the draft of a boiler could be obtained by cleaning out the smoke connection to the chimney. Is this true and if so, why?

Ques. 5—Why can direct-expansion ammonia coils be run almost full at part load, while at full load it is impossible to carry them more than three-quarters filled?

Ques. 6—What is meant by the elastic limit of a steel?

Ques. 7—In a slide-valve steam engine, what kind of piston is used generally?

Ques. 8—With an Edwards condenser air pump how is the air drawn out of the condenser?

Ques. 9—In some turbines pitting is found on the casing opposite the low-pressure blading. What is the cause?

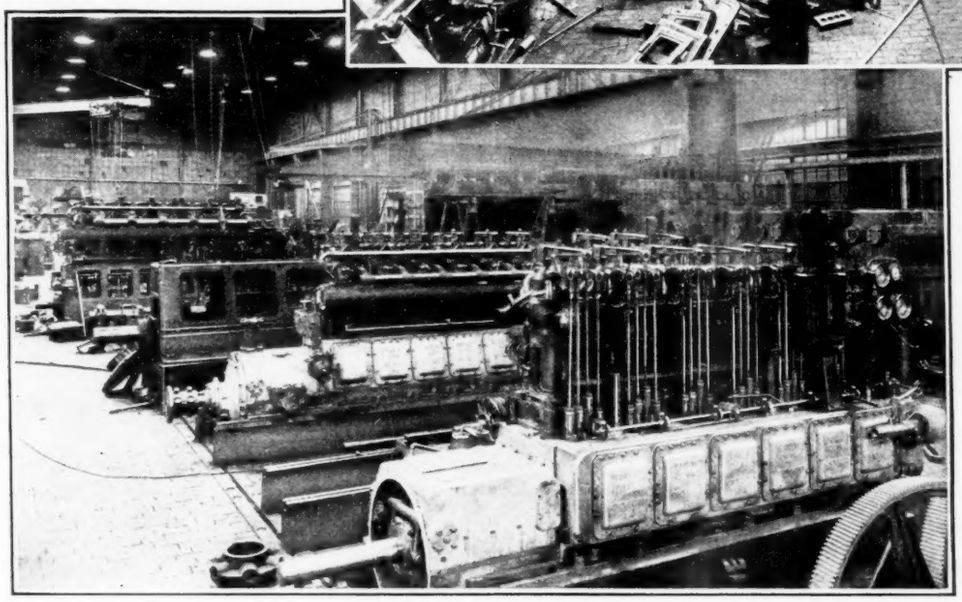
Ques. 10—At what power factor is the power component of the current, in an alternating-current circuit, equal to the reactive component?

POWERGRAPHS

Building Diesel Engines

Left — General view of test floor where marine Diesels are erected

Right — Machining connecting rods and other heavy parts



Left—Solid-injection engines under test

Photographs were obtained at the works of the Bessemer Gas Engine Company

Combustion Control Formulas

I—Introduction

By E. A. UEHLING
President Uehling Instrument Company

THIS begins a series of articles that will later be published in book form, in which the author derives a number of combustion formulas based on a new equicalorific fuel unit. He also shows how these formulas can be used for combustion control purposes. This introductory article gives a background for following installments.

THE operating engineer is responsible for the proper functioning and economic operation of the machinery in his immediate charge or over wihch he has direct supervision. If he measures up to his responsibility, he will want his boilers, engines and pumps to function smoothly, effectively and economically. He will not wait for a kick from above before he bestirs himself to bring the efficiency of his plant up to a satisfactory level.

Because a given boiler plant is easily producing all the steam required, is no sign that it is operating economically. Because a plant was tested and overhauled a month or six months ago and left giving satisfactory results, is no guaranty that it is not operating quite wastefully today. Without control there can be no assurance against wasteful operation. Control by coal weigher and water meter is better than no control at all, insomuch as it is better to know today what the boilers did yesterday than not to know at all. It is also better to know approximately how the boiler plant performed as a whole than to guess at it. In order that the operating engineer may exercise effective control over his boilers, it is not sufficient that he have the means of knowing tomorrow how his boilers are performing today, nor how well or badly they are operating on the whole. To exercise intelligent and effective control he must have the means of knowing how every individual boiler is functioning *now*, and if found below the established economic standard, how much below and to what the wasteful operation is due.

Before the engineer can tackle the problem of attaining maximum boiler efficiency, he must not only know how much of the heat in the fuel consumed is lost, but how much of this loss is avoidable. He must further know where the heat losses occur and to what they are due. It goes without saying that practical experience is the paramount requirement in the professional equipment of a successful operating engineer, but the headlight of science is none the less a necessity.

Diagnosis must precede the application of the remedy. A remedy cannot be intelligently applied unless the nature of the trouble is known. To bring his boilers up to maximum efficiency, the engineer must know (*a*) how much of the heat contained in the fuel is going to waste, (*b*) to what the heat losses are due and (*c*) what part of the waste it is possible to eliminate. Not until he knows these facts can he proceed intelligently and effectively to bring his boilers up to the highest efficiency that his plant and operating conditions permit.

The generation of steam in a boiler depends on two distinct phenomena: (*a*) Combustion and (*b*) Absorption. The former liberates the heat contained in the fuel, and the latter transfers the heat to the water in the boiler. Combustion is a chemical phenomenon and can be correctly diagnosed only by chemical means; that is, by analyzing the fuel and the products of combustion. Absorption is a physical phenomenon and must be diagnosed by physical means; that is, temperature of gas, temperature of steam, conditions of heating surface, etc.

When two elements combine with each other, they liberate a definite amount of heat. Thus 1 lb. of carbon combining with $2\frac{3}{4}$ lb. of oxygen liberates 14,600 B.t.u. and 1 lb. of hydrogen combining with 8 lb. of oxygen liberates 62,000 B.t.u. Elements that readily combine with oxygen are called combustibles and the reaction between oxygen and such elements is called combustion. The combustible elements in all commercial fuels, whether gaseous, liquid or solid, are carbon and hydrogen. Sulphur is also a combustible constituent of coal, oil and gas, but because of the small amounts contained in the fuels and its low heating value, it need not be considered here. Air is called the supporter of combustion and is composed of a mixture of oxygen (O) and nitrogen (N) and a small percentage of other gases which act the same as nitrogen and can therefore be treated as such, so that for combustion purposes air is considered to be a mixture of oxygen and nitrogen:

Consisting by weight of 23 per cent O and 77 per cent N, or

Consisting by volume of 21 per cent O and 79 per cent N.

Chemistry is the science that formulates and applies the laws according to which reactions between the elements take place. Combustion is a chemical phenomenon because it is the chemical reaction between the oxygen of the air and the carbon and hydrogen in the fuel. The

nitrogen, like the ash in the coal, acts only as an incumbrance on the process of combustion.

The gaseous products of complete combustion of carbon and hydrogen are: Carbon dioxide (CO_2), steam (H_2O) and nitrogen (N_2). The chemical symbol CO_2 denotes that two atoms of oxygen have combined with one atom of carbon to form one molecule of carbon dioxide. The symbol H_2O denotes that one atom of oxygen has combined with two atoms of hydrogen forming one molecule of steam. N_2 denotes that the nitrogen remains unchanged by the process of combustion.

Now since the atomic weight of carbon is 12 and that of oxygen is 16, the symbol CO_2 tells us that 12 lb. of carbon requires $2 \times 16 = 32$ lb. of oxygen for its complete combustion and that one pound of carbon therefore combines with $\frac{32}{12} = \frac{8}{3} = 2\frac{2}{3}$ lb. of oxygen forming $3\frac{2}{3}$ lb. of CO_2. But since air is composed of 77 per cent of nitrogen and 23 per cent of oxygen, it will require $\frac{8}{3} \times \frac{100}{23} = 11.6$ lb. of air to burn one pound of carbon completely. Similarly, it takes $16 \div 2 = 8$ lb. of oxygen and $\frac{8 \times 100}{23} = 34.8$ lb. of air to burn one pound of hydrogen. Therefore, if we know the weight of carbon (C) and available hydrogen (Ha) contained in a unit of fuel we can readily calculate the weight of air consumed in burning one unit of fuel by the simple formula $11.6 \times C + 34.8 \times Ha =$ the theoretical weight of air required for the complete combustion of one fuel unit. This equation neglects the sulphur content of the fuel, thus introducing an error less than 2 per cent.

The pound is the commercial unit of weight, and it was but natural that all heat-loss calculations and determinations of boiler efficiency should have been based on the pound as the unit. Pounds of water evaporated per pound of coal was naturally the first standard by which it was attempted to judge and compare boiler efficiency. It was, however, soon learned from practical experience that coal varied greatly in its capacity to produce steam. Because of this variation a correct estimate and fair comparison of boiler efficiency cannot be made by merely dividing the weight of the water evaporated by the weight of coal fired. The method cannot give correct results because the pound of coal as fired is not a true measure of the heat expended and the pounds of water evaporated is no true measure of the heat in the steam produced.

It was evident from the first that the discrepancies between results obtained from the same kind of coal must be due to the impurities in the coal, ash and moisture, which both displace combustible elements contained in coal. Basing the evaporation on the ash and moisture-free coal—that is, on the pound of combustible—more concordant results were obtained. However, it was discovered that even the pound of combustible does not have the same heating value for all coals, so that the B.t.u. per pound, which can be readily determined by the bomb calorimeter, is now the only recognized unit for comparison. As the science of steam engineering progressed, the effect of the feed water temperature, the steam pressure and superheat were accurately determined, and must be taken into consideration in accurate boiler testing. All these factors and many others are embodied in the rules for testing boilers, evolved by a specially qualified committee of the American Society of Mechanical Engineers.

Up to fifty years ago even the most up-to-date operating engineer had no means of knowing anything definite about the composition or heating value of the coal he was using and much less about his heat losses or the process of combustion.

The first ray of scientific light came from the science of chemistry, which had discovered the elements of which coal is composed and determined accurately the percentage of each element it contained. Chemistry also discovered the fact that the only two combustible elements of practical importance are carbon and hydrogen. Sulphur is also a combustible element contained in coal, but since it is present generally only in small amounts and is of low heating value, it is of no practical importance as a combustible. Chemistry had discovered further that air is composed of oxygen and nitrogen and that oxygen is the supporter of combustion. That combustion is nothing more or less than the reaction between the oxygen of the air and the combustible elements of the fuel by virtue of which the potential heat energy stored in the fuel is liberated. Chemistry furthermore found ways and means to analyze the products of combustion and found that they are composed of carbon dioxide (CO_2) carbon monoxide (CO), water (H_2O), sulphurous acid (SO_2), nitrogen and free oxygen in quantities depending on the composition of the fuel and the percentage of excess air supplied.

After chemistry had revealed the correct elementary composition of coal, the science of physics stepped in and accurately determined the heating value of carbon, hydrogen and sulphur. These values per pound of the respective elements are: Carbon, 14,600 B.t.u.; hydrogen, 62,000 B.t.u.; sulphur, 4,000 B.t.u. Then the mathematician came and evolved the formula $146 \times C + 620 \times \left(H - \frac{O}{8}\right) =$ B.t.u. per pound of coal, in which C = per cent of carbon, H = per cent of hydrogen and O the per cent of oxygen contained in the coal. This is a simplification of what is known as Doulong's formula. Thus, if the composition of a given sample of coal is known, its heating value can be calculated with a close degree of approximation.

The greatest obstacle in the way of supplying the operating engineer with the means necessary to correlate and interpret the information recorded by the instruments designed and installed for the purpose of controlling boiler operation, is the variation in heating value of the pound fuel unit. Because of this great variation in the heating value of a pound of coal as fired, the conventional formulas evolved for calculating heat losses and other necessary factors are too complicated and too difficult to apply to be useful to the busy operating engineer. Furthermore, to be able to apply these formulas correctly, it is necessary to know the ultimate analysis of the coal and a complete analysis of the flue gas, which knowledge is seldom at the command of the operating engineer of the average power plant.

In the next article the author derives an equicalorific fuel unit that he terms the pound carbon unit, as it consists of a weight of fuel containing one pound of carbon.

ELECTRICAL *Operation and Maintenance*

Electric-Elevator Signals

How Annunciator-Lamp Relay Systems Operate*

By F. A. ANNETT
"Power" Editorial Staff

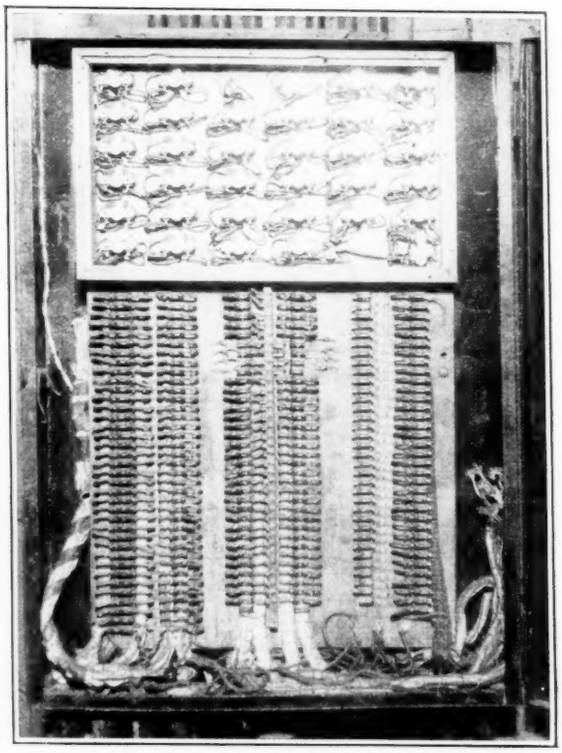


Fig. 1—Relay panel and terminal board

WITH the conventional type of elevator light-annunciator signal system there are two operations that must be provided for: First, a means of closing the annunciator signal-light circuit and holding it closed until the signal has been answered, by the operator taking the car to the floor where the signal was given; second, some device should be provided to restore the signal to normal position when the call has been answered.

One of the ways of accomplishing these two objects is to use a relay-type push button. As described in the previous article,[1] this type of push button when pushed to the closed position, completes the signal-lamp circuit and is held by mechanical means in the closed position until released by a relay coil in the push button. This relay coil may be energized either by a push button on the annunciator in the car or by an automatic reset machine.

Another method of closing the signal-lamp circuit is to use the landing button to energize a relay coil, which in turn closes a contact to complete the annunciator lamp circuit. The lamp circuit, when once closed by the relay, remains closed until opened by a second coil in the relay, which can be energized either from a push button on annunciator in the car or by an automatic reset machine. It is with this type of equipment that this article deals. Except that the push buttons are constructed to withstand the severe conditions of elevator service, they are of the conventional type that complete the circuit when pushed to the closed position and immediately open the circuit when released by the one giving the signal.

Figs. 2 and 3 show the type of elevator signal relay used by the Holtzer Cabot Electric Co. When coil *C*, Fig. 2, is energized by pushing a landing button, it attracts the relay's armature and causes it to close contacts *A* as in Fig. 3. These contacts are held closed by a small weight *W*, which is to the left of a vertical passing through the axis of the armature shaft. When coil *C'* is energized, either by pushing a reset button on the annunciator in the car or by the closing of a contact on an automatic reset machine, the armature of the relay is thrown to the position shown in Fig. 2. This operation opens contacts *A*, which are held open by weight *W* being to the right of the vertical passing through the armature-shaft's axis. In this relay the armature rotates through a small arc, being pivoted at *P*.

One relay is required for each up or down landing button. A ten-landing hoistway would require 19 relays, two for each of the intermediate-floor push buttons, one for each of the two terminal landings, and one for the

*All rights reserved.
[1]Page 667, Nov. 1 issue.

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buzzer. At the terminals the car can be signaled in only one direction, therefore requiring only one relay for each button. All the relays are assembled on a panel board in the elevator-machine room, as shown in Fig. 1.

The operation of this system will be made clear by a study of Fig. 4, which is a simplified diagram for a four-landing signal system. Assume that the second floor up button U_2 is pushed. This will close a circuit from the + side of the power source through coil C of relay U_2, through push button U_2, the buzzer relay coils R and to the — side of the power source. Completing this circuit energizes coil C of relay U_2 and causes it to close contact U'', and also energizes coils R of the buzzer relay, and it closes contact R'.

After contact U'' is closed it remains closed and maintains a circuit for No. 2 lamp in the up-direction side of the car annunciator. This circuit is from the + side of the power source, through contact U'' to the terminal board in the hoistway, through up-direction signal lamp No. 2 and returns to the — side of the power source. This operation lights No. 2 up-direction lamp, which remains lighted until the car has come in the up direction to the floor.

Closing the buzzer relay contact R' makes a circuit for the annunciator buzzer on the car, from the + side of the power source through contact R', the buzzer coils on the annunciator and to the — side of the power source. This circuit sounds the buzzer to attract the operator's attention to the call. The buzzer-relay contacts are arranged so that they remain closed only as long as the coils R are energized, which is only when a push button is held closed. This is all that is required to call the operator's attention to the signal. Each time a button is pressed the buzzer will sound.

One side of each push button connects to a common wire that runs to the left-hand coil of the buzzer relay, and the other side of each push button is wired to its respective up or down lamp relay coil. This arrangement

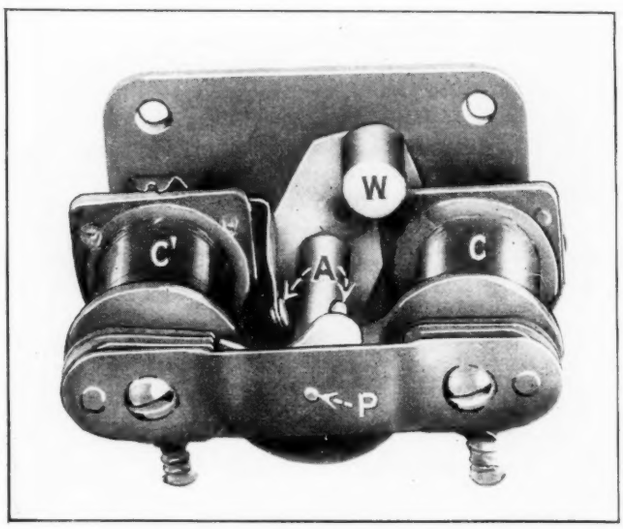

Fig. 2—Signal-lamp relay with contacts open

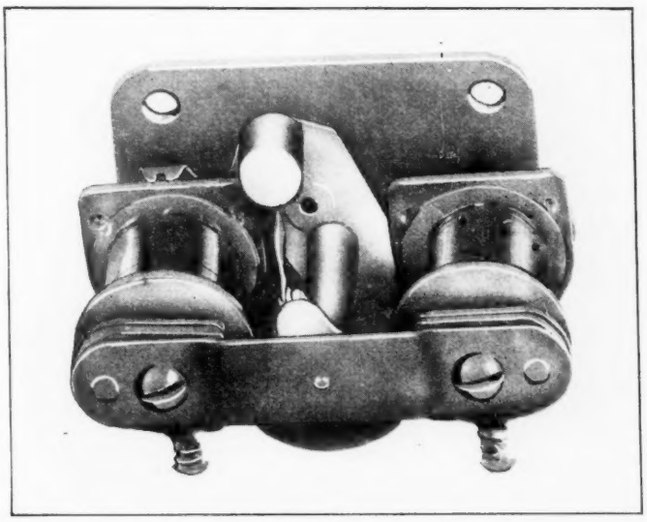

Fig. 3—Signal-lamp relay with contacts closed

puts the buzzer relay coils in series with whichever lamp relay coil is made alive by pushing a landing button.

When the car leaves a landing after picking up the passengers, a contact is closed on the reset machine which completes the relay reset-coil circuit to clear this floor signal from the annunciator. For instance, assume that the car comes up to the second floor. Just as it leaves this floor, the contact arm on the reset machine makes contact with button U_2. This completes a circuit from the + side of the power source through resistance R'', coil C' on relay U_2, contact U_2 on the reset machine, the cutout button on the annunciator and to the — side of the power source. Making this circuit alive, energizes coil C' and causes it to open contact U'' and open the circuit of lamp No. 2 in the up bank of the annunciator.

The cutout button on the annunciator is used by the operator to prevent the reset machine from removing a signal from the system if this should be desirable. Where two or more cars are operating in rush hours, one may have a full load when only part of the trip is made and therefore cannot take passengers off the other floor. To prevent the reset machine from removing the signals from the system, for the floors passed without stopping for passengers, the operator pushes the cutout button and opens the reset machine circuit. The signals then remain on the other cars for the operators to answer.

The reset machine, as explained in the previous article, has two contacts on its arm, one for each direction of car travel. These are arranged so that only one makes contact in a given direction of car motion, consequently if the car is going up only, the up signals are reset; likewise, if in the down direction only, the down signals are reset, when answered.

In this article the circuits for the second floor up signal only have been traced. However, the reader should have no trouble in following out the circuits for the other signals, as they are identical to the one described. Where there is more than one car, each annunciator may be

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wired to its terminal block in the hoistway and these blocks connected in parallel, as shown in the previous article. For one bank of elevators there is one set of push buttons and one group of relays, but a reset machine is provided for each car. A relay contact, when closed, lights a lamp on each car annunciator simultaneously, and the lamps are put out by the reset machine of the first car answering the call, unless prevented by the operator.

Sometimes, with the system just described, one terminal of all wiring is taken to a terminal board below the

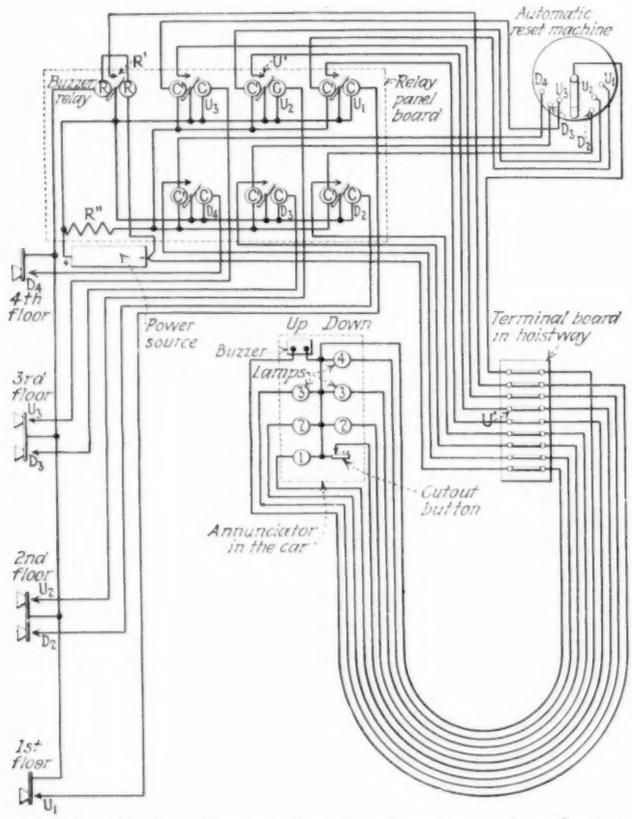

Fig. 4—Wiring diagram for signal system using the type or relay shown in Figs. 2 and 3

relay panel as shown in Fig. 1. The landing push-button wiring, the relay leads, the wiring from the hoistway terminal blocks, and the wiring from each reset machine are brought directly to the terminal board and connected to binding posts. The cross-connections between the various devices are made by connection between the binding posts. This arrangement makes it convenient when locating trouble. In some cases the traveling cable runs directly from each car to the terminal board in the motor room without a break, which eliminates all connections in the hoistway.

With all the wiring brought to a common point and each wire marked, it is a comparatively simple matter to trace each circuit and test it. By allowing some spare wires in the cables used to make the different connections, a circuit failure is easily taken care of by the spaces.

Starting Diesel-Electric Unit as a Motor

THE final answer to the question "How Would You Do It?" as given in Oct. 11 issue, in my opinion, cannot be definitely covered without first having all the data available and obtaining from the makers of the engine and generator certain information regarding the starting characteristics of these machines.

The feasibility of starting the Diesel unit by means of the generator functioning as a motor, with energy furnished by the steam-engine-driven unit, will depend upon the starting characteristics of the generator when operated as a motor. Assuming that the Diesel engine is of the four-cylinder type, it may be possible to start with two cylinders working, which will relieve the starting duty on the generator used as a motor. The engine makers should be able to give the starting torque necessary to start the engine under any condition, and the generator builders can readily tell whether the electrical characteristics of the generator as a motor will be suitable for this duty.

A test can readily be made by closing the main circuit breakers when both units are at rest, and with the field of Diesel unit short-circuited through its rheostat and field discharge resistance and its exciter disconnected, the steam unit is then brought up to a speed, with its main and exciter rheostats cut out, until about 150 per cent of full load current flows in the stator circuit. If the Diesel unit does not start, some help applied to the flywheel with a bar may be sufficient to cause it to turn slowly, and once it does begin to turn, the speed of the steam unit can be increased until the cylinders of the Diesel begin to fire. With the Deisel engine in good shape a few revolutions will be sufficient to accomplish the result as a rule.

Since this method of starting is an emergency one and the current value will be above normal for a short time, the main ammeter may actually read off scale for a few minutes until the Diesel unit is up to speed. Once the cylinders begin to fire and the current drops to normal or lower, the field switch may be closed in its normal position, and all the rheostats of the steam as well as the Diesel unit adjusted as the voltage and speed of the two units begin to pick up rapidly when the Diesel unit starts.

As previously stated, the actual success in using this method of starting will depend upon the characteristic of the generator when operated as a motor, and the test referred to can be easily made. In my experience tests at one station showed that the steam unit throttle could be opened at will and the other set would pick up at once, but this happened to be an exceptional case and other units needed considerable "urging" to make them turn over.

It would seem advisable, therefore, if the simple test, as described, will not accomplish the desired result, to communicate with the generator maker, who may be able to obtain results by a slight modification in the generator-field structure.

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ELECTRICAL *Operation and Maintenance*

Reversing an Interpole Motor

A SHUNT motor without interpoles may be reversed by interchanging either the armature or the field leads, so as to change the direction of current through either the armature or the field coils. This is also true of commutating-pole (interpole) type machines, but the armature circuit must also include the interpole winding.

In one case in mind an attempt was made to reverse an interpole shunt motor, but when reversed direction of

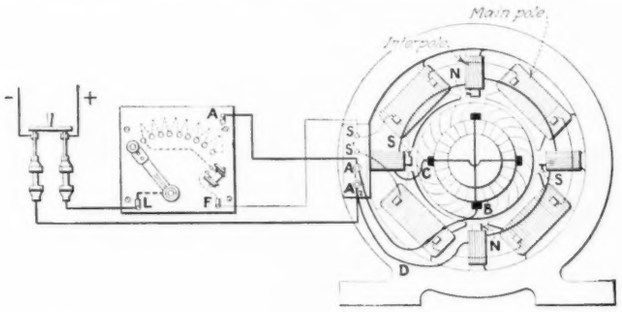

Fig. 1—Connections of interpole shunt motor for one direction of rotation

rotation was obtained, it was accompanied by severe sparking at the brushes and a decided decrease in speed when load was applied. The cause of the trouble was found to be due to crossing the armature leads at the brush-holders, such as interchanging the armature leads at *B* and *C*, Fig. 1. The proper way to reverse the motor is to interchange the leads at terminals A_1 and A_2. If Fig. 1 shows the correct connections for one direction

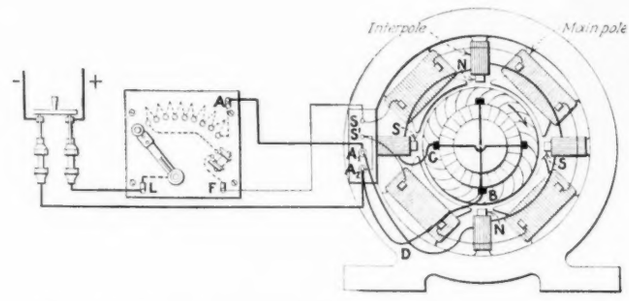

Fig. 2—Connections of motor, Fig. 1, for opposite direction of rotation

of rotation, then Fig. 2 is correct for the opposite direction, the leads being crossed at *D*.

Without interchanging the leads from the brushes, the motor could be reversed by connecting the line wire and *S'* field terminal to armature terminal A_1, and the *A* terminal on the starting box to A_2 on the motor. The simplest method of reversing an interpole shunt motor is to interchange the field leads. For example, in Fig. 1 connect the *S* field terminal to the A_2 armature terminal and the *F* terminal on the starting box to *S'* on the motor. If the motor is compound-wound, then it will generally be easier to interchange the direction of the current through the armature and interpole windings. If the shunt-field coil leads are interchanged, then the series must be also, to retain the correct polarity relation for the two windings.

C. O. MILLS.

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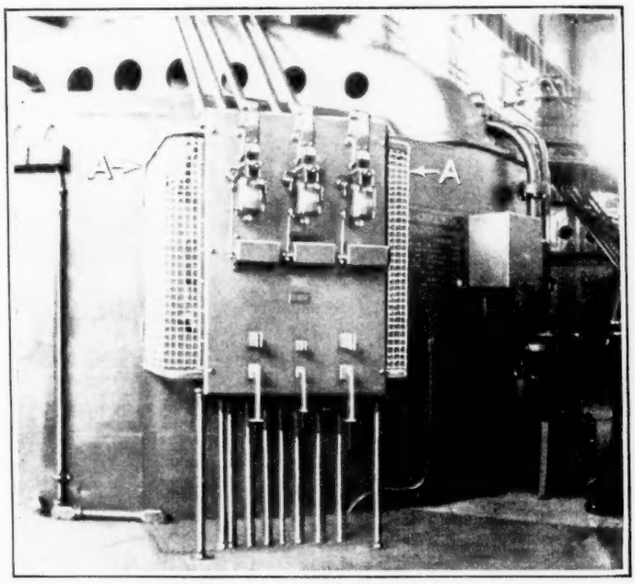
Easily Removed Guard for Panel Boards

MANY hydro-generators and other items of electrical equipment have small panel boards mounted on a pipe framework adjacent to the equipment. It is customary to provide a guard between the panel board and the equipment, as indicated at *A* in the figure, in order to prevent persons and material getting behind the board and causing trouble. The guard often consists



Hinged guard for panel boards

of a 2-in. mesh screen with a framing of light angle iron and this frame is in turn bolted to the equipment and to the panel board pipe frame.

Occasionally, a repairman must clean, adjust or repair the equipment or wiring on the rear of the panel board, and much time is required to remove the guard.

In one hydro plant the difficulty was overcome by applying two butt hinges to one end of the frame and fastening the other half of the hinge to the frame of the generator. A small piece of angle iron was secured to the panel pipe frame by means of U-bolts at a point about even with the top and the bottom of the guard frame. A small plate was bolted to the top and bottom of the guard and overlapped the angle iron pieces. A $\frac{3}{8}$-in. hole was drilled through the angle iron and the plate so that the holes would register when the guard was closed. A $\frac{1}{4}$x$1\frac{1}{2}$-in. clevis pin dropped in the holes secured the guard in the closed position.

Alcoa, Tenn. J. ELMER HOUSLEY.

Simplified Chart *for* Air Calculations

By W. V. Fitzgerald

MUCH difficulty has been experienced with the use of charts for air calculations. Temperature-entropy charts involve many curved lines that intersect at confusing angles, making them difficult to construct and read, and they are generally rather less accurate that is desirable. Logarithmic charts offer some advantages, particularly if the co-ordinates and scales are well selected. In fact, the usefulness of the chart appears to depend much upon these features.

The accompanying chart is based on the perfect-gas laws that are generally applied to air, and does not take account of the variations of specific heat or other departures from these laws. However, the inaccuracies from this source are small within the usual working range.

The principal formulas expressed by this chart will be given to show the simplicity of the chart calculations as compared with the use of formulas.

Pressure, Volume, Temperature Relations

The general relation among pressure, volume and temperature, for formula use, must be expressed in absolute units, thus: p = absolute pressure in pounds per square inch; v = volume of one pound of air, measured in cubic feet; T = absolute temperature, deg. F. plus 460.

Using these units the formula is $\frac{pv}{T} = 0.370$.

With this formula, if pressure and temperature are known, volume per pound can be calculated, or if pressure and volume per pound are known, temperature can be found; or if volume per pound and temperature are known, pressure can be determined.

This formula is expressed in the chart by the vertical lines, which represent the absolute pressures indicated by the scale at the bottom or the gage pressures indicated by the scale at the top, by the horizontal lines, which indicate the temperature in degrees Fahrenheit shown by the scale at the left margin; and by the heavy diagonal lines for volume per pound of air, the values being read by the figures arranged diagonally across the face of the chart.

This part of the chart permits the easy solution of such examples as the following:

What is the volume occupied by 10 lb. of air at a temperature of 90 deg. F. and a pressure of 500 lb. gage?

On the scale at the left of the chart find 90 deg. F. and follow the horizontal line to the right across the chart. On the scale at top, find 500 lb. gage, and follow vertically down to the 90-deg. line. The point of intersection is between the volume lines for 0.38 and 0.40 cu.ft. per lb. and, by interpolation, reads 0.396 cu.ft. per lb. Thus 10 lb. of air will ocupy $10 \times 0.396 = 3.96$ cu.ft.

Compression and Expansion of Air

Other formulas represented by the chart are based on the laws of adiabatic compression or expansion of air. Such a compression or expansion is one in which no heat is added to the air or taken from it while it is undergoing the change. This is practically true of any piston compressor or motor, unless it operates at very slow speed. These formulas show how pressures, volumes and temperatures change during such a compression or expansion.

p_1 and p_2 are the initial and final pressures, pounds per square inch absolute.

v_1 and v_2 are the initial and final volumes, cubic feet per pound.

T_1 and T_2 are the initial and final absolute temperatures, 460 + temp. deg. F.

$$\frac{p_2}{p_1} = \left(\frac{v_1}{v_2}\right)^{1.406} \text{ or } \frac{v_1}{v_2} = \left(\frac{p_2}{p_1}\right)^{0.71}$$

$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{0.29} \text{ or } \frac{p_2}{p_1} = \left(\frac{T_2}{T_1}\right)^{3.45}$$

$$\frac{v_1}{v_2} = \left(\frac{T_2}{T_1}\right)^{2.46} \text{ or } \frac{T_2}{T_1} = \left(\frac{v_1}{v_2}\right)^{0.406}$$

Many readers are familiar with these formulas and know the inconvenience of working out the values of these fractions with odd exponents.

All of them are expressed on the chart by the equally spaced diagonal lines marked with various values of S, which represents "entropy" above an arbitrary base line. These lines are of service in solving problems involving changes of pressure, volume and temperature during adiabatic compression or expansion, of air, as indicated by the following examples.

Atmospheric air at a temperature of 75 deg. F. is compressed in a high-speed compressor, assuming compression to be adiabatic, to a pressure of 60 lb. gage. What will be the discharge temperature?

On the chart find the vertical line for zero gage pressure or 14.7 lb. absolute, and find the point A on this line corresponding to 75 deg. F. This point happens to be on the diagonal line marked $S = 0.98$, which is a constant entropy line. The adiabatic compression is represented by following upward along this diagonal line to the point B where the pressure is 60 lb. gage, as indicated by the scale at the top. The temperature scale for this point is found to read 397 deg. F., which is the discharge temperature.

If the compressor takes in 300 cu.ft. of free air per minute, what volume of air will be discharged?

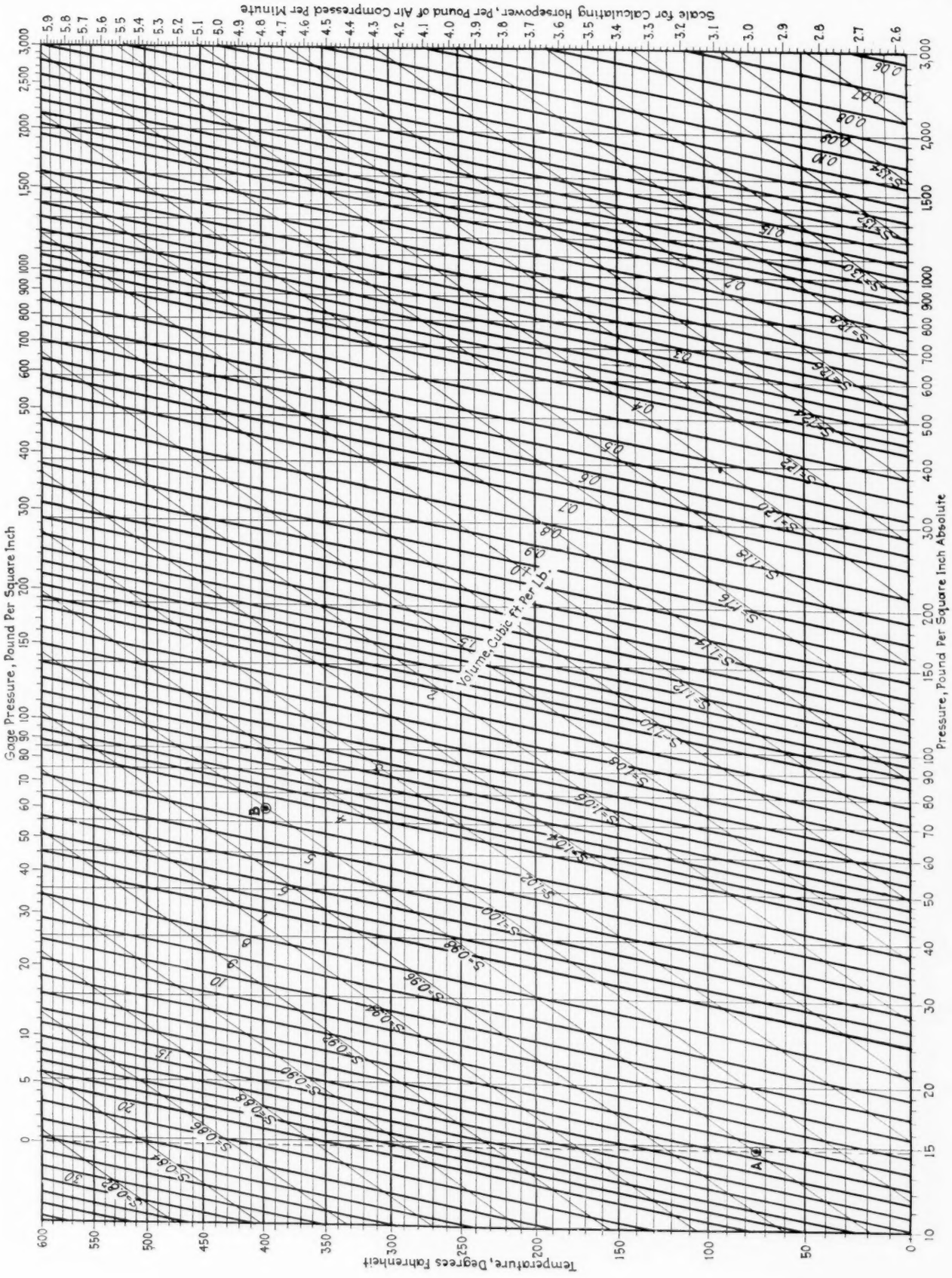
For the point A the volume scale reads 13.4 cu.ft. per lb. and for the point B the volume scale reads 4.22 cu.ft. per lb. Since the problem assumes 300 cu.ft. of free air per minute, the volume of air discharged will be:

$$300 \times \frac{4.22}{13.4} = 94.6 \text{ cu.ft. per minute}$$

Power for Compression

The formula for horsepower necessary to compress air may be written in many ways, one of which is as follows:

$$Horsepower = \frac{3.464 \times 144}{33{,}000} p_1 V_1 \left[\frac{(p_2)^{0.29}}{(p_1)} - 1\right]$$


Scale for Calculating Horsepower, Per Pound of Air Compressed Per Minute
Gage Pressure, Pound Per Square Inch
Pressure, Pound Per Square Inch Absolute
Temperature, Degrees Fahrenheit
Volume, Cubic Ft. Per Lb.
A
B

where p_1 = suction pressure, pounds per square inch absolute; p_2 = discharge pressure pounds per square inch absolute; V_1 = volume of intake air, cubic feet per minute.

The use of this formula requires the use of logarithms, and to those not accustomed to the calculation, there are many chances of error.

Another Method of Calculating Horsepower

There is another method of calculating the horsepower —not so generally known but often easier to use, especially in connection with such a chart as this. It depends on the law that during a reversible cycle such as that of a compressor the work done is equal to the heat change. This is also true of adiabatic expansion and compression, since there is no heat added or given off during such a process, and therefore any work done must be at the expense of heat energy; or, conversely, any work done on the air must show itself as an increase in heat energy. Since the change of heat energy in air is equal to the product of its specific heat at constant pressure multiplied by the difference in temperature, one may find the theoretical work done in a compressor by multiplying this product by the mechanical equivalent of heat, which is 778 ft.-lb. per B.t.u. and the horsepower per pound of air compressed per minute may be expressed as follows:

$$Hp.\ per\ lb.\ air\ per\ min. = \frac{778}{33{,}000} C_p\,(T_2 - T_1).$$

This formula is not difficult to use. Specific heat of air at constant pressure (C_p) is not quite constant, but can be assumed to have an average value of 0.237. To further simplify this process, however, a scale has been constructed on the right margin of this chart by which the result may be secured by two readings and a subtraction. In other words, the horsepower per pound of air per minute can be ascertained by reading this scale from the lower and upper points which show the beginning and end of compression, and subtracting the smaller reading from the larger one, for example:

What will be the horsepower required per pound of air compressed under the conditions given in the previous problem?

The points A and B, on the chart, show the initial and final conditions of the air. For the point A the reading of the scale at the right is 2.99. For the point B the reading is 4.79. Subtracting the former from the latter gives 1.80 hp. per lb. of air.

What will be the theoretical indicated horsepower of a compressor which takes in 300 cu.ft. of free air per minute?

The volume at the point A is 13.4 cu.ft. per lb. By dividing 300 by 13.4, it is found that the compressor is taking in 22.4 lb. of air per minute. Since the horsepower per pound per minute is 1.80, the total horsepower is $1.80 \times 22.4 = 40.3$ hp.

Accuracy of Chart

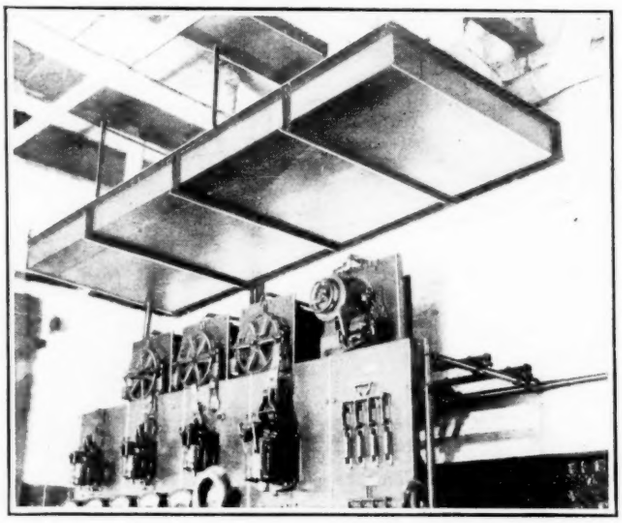
Calculation of these same problems by the complex formulas shows that the results are the same except for slight errors, usually well within one per cent. When it is considered that pressures are read on gages that are often out by larger percentages, chart calculations appear to be sufficiently accurate.

It is true that there are slight inaccuracies due to the facts that air is not quite a perfect gas and that its specific heat is not a constant. The differences of this nature have been thoroughly investigated for air of low temperature, because of the problems of liquid air, and in that region the differences are of importance. But for higher temperatures the differences are small and are not so well known.

When research has brought out more definite knowledge of the properties of air, it will be easy to reconstruct the diagram to allow for these differences. Indeed, the use of diagrams will then be necessary, as this will be practically the only way to make full use of the new data.

Drip Pan To Protect Switchboard

IT IS often necessary to install switchboard apparatus in places where steam pipes pass directly overhead in order to facilitate operation. This arrangement exposes the apparatus to a service interruption hazard due to the possibility of one or more of the pipes leaking at the joints. In the Burlington power plant of the Public Service Gas & Electric Company of New Jersey it was found necessary to install a switchboard in this manner, and to safeguard it against a possible steam-pipe leak a drip pan was installed over the switchboard, directly under the pipes.



Drip pan for switchboard protection

This pan is made of $\frac{1}{16}$-in. sheet iron with welded seams and is 48 in. wide, 12 ft. long and 10 in. deep. It is reinforced with 1-in. angle and suspended on 1-in. flat iron hangers fastened to the floor I-beams. It is given about a 10-in. pitch, and a $2\frac{1}{2}$-in. drain pipe is installed in the low end.

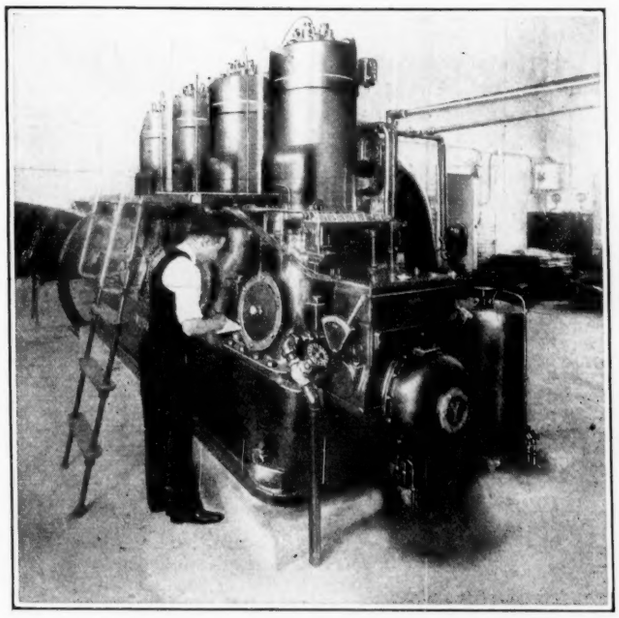
Although no failure has occurred on the overhead piping, it was considered a good investment to install this plan to guard against a possible service interruption.

Foresight in such matters is always better than hindsight. Because something has not happened is no insurance that it will not. Experience has shown that failures frequently develop under unexpected circumstances at the most inopportune times. Installing the drip pan in the anticipation that something might happen that would cause damage to the switchboard, is a good example of forethought in plant operation.

INTERNAL COMBUSTION ENGINES

Engine-Room Records in Oil-Engine Plants

By A. B. NEWELL



TO MAKE an intelligent analysis of what has transpired in an engine room it is necessary to have records for reference. These should cover the amount of supplies used and tell an understandable tale of important events in the engine room, making it possible to review conditions in the consecutive order of their occurrence and to know how they existed at the time the record was made.

There are so many different types of oil engines that it is not possible to have a single system that will apply to all. In large plants so much is at stake that it is necessary to have a capable operator in the engine room constantly, while in some small ones he must divide his attention between the engine and other duties of equal importance in order to justify the expense of retaining him. In the latter instance the maintenance of records is of considerable importance, for the engineer having several duties to perform may neglect to check up on his engine unless some sort of rule is employed which calls for writing down what is taking place. Failure to check up on the engine is more commonly the result of preoccupation than indolence.

The development of small "foolproof" engines has encouraged neglect, yet common sense tells us that we must give these engines some attention even though they may be let run for longer periods without attention than can safely be done with larger units. This is not because the small engine is likely to run longer or more satisfactorily without attention than will larger ones, but because the relative danger to life and property, as well as the cost of repair, is considerably less with the small engine in the event of an accident.

We find it difficult to draw a hard and fast line between the class of plant requiring an engineer with divided duties and the one in which he devotes all his time to the engine or engines. In drawing conclusions relative to economy in this matter, we should not lose sight of the fact that with fairly large engines—50 hp. to the cylinder or more—it will not take a very serious accident, as the result of not having an engineer in the engine room, to pay the salary of such a man for several months.

The oil engine is used to fill a multitude of power needs, all of which are not governed by the mere requirement of making wheels turn at certain predetermined speeds with a power output equal to the demand. There are more specific requirements of speed, weight, stamina, dependability and, quite often, first cost, with modifications made to meet several such requirements in a single engine.

Obviously, not all engines present the same operating problem, although the general principle is about the same. This is despite the fact that some admit air and expel exhaust gases through ports in the cylinder walls, while others employ valves in the cylinder head for the same purpose; some use air injection, some solid injection, some have high compression and some do not have such high compression.

If, by observing these many different engines at their best and their worst, we may obtain instructive information about them, it is worth while to make records of such observations, with the one all-important objective of reducing the cost of power production.

The operators are constantly making such observations, and half of them are remembering them, while the other half are using them to fill an immediate need.

Temperature observations of the exhaust gases and cooling water are without a doubt the most important. They not only indicate the condition of combustion, cooling effect and load, which have a direct bearing on the

INTERNAL COMBUSTION *Engines*

general physical well being of the engine, but also tell how these are distributed throughout the various cylinders of a single unit. They are not, however, a positive indication of what the load is or how efficiently the engine is being cooled and when recorded for the purpose of comparison with other indications, such as the instrument readings taken from a switchboard, indicator diagrams or the flow of cooling water, they serve a second purpose of equal if not such immediate importance. That comparisons such as these covering a long period of operation cannot be made at the time of taking the readings is quite obvious.

Assume for the sake of illustration that the cylinders record. Surely, not all of those we take, unless the engine is under special test, and as surely some of them, no matter what the condition or method of operation may be. I mean that we should not employ a system that is more complicated and difficult to run than the engine itself. If a complex system is used, many fake figures will be entered, and they are worse than no figures at all.

There should be two general classes of records, one a daily log sheet with notations of the various temperatures, pressures, rates of fuel and oil consumption, load condition, exhaust color, etc. In combination with this there should be a diary form of record, with entries of the various repairs made, spare parts fitted, peculiar

SHEET No._____ **DAILY LOG SHEET ENGINE No.**_____ DATE_____

TIME	R.P.M.	TEMPERATURES														PRESSURE									
		CYL. COOLING WATER				PISTON COOLING WATER OR OIL			EXHAUST			LUB. OIL COOLER		SCAVENGING AIR			INJECTION AIR	COMPRESSOR STAGES			WATER	OIL	FUEL	RESERVE AIR BOTTLES	
NOON		WATER INLET	1	2	3	1	2	3	1	2	3	IN	OUT	1	2	3		1	2	3				1	2
2																									
4																									
6																									
8																									
10																									
12																									
2																									
4																									
6																									
8																									
10																									
12																									

CHARACTERISTIC AND REMARKS											
	LOAD CONDITION			EXHAUST COLOR			LUB. OIL, GALLONS			FUEL OIL	USE SPACE BELOW AND BACK OF SHEET FOR REMARKS. ENTER TIME OF STOPS AND STARTS
NOON	VOLTS	AMP.	KW.	1	2	3	CYL.	BEARINGS	COMP.	GALLONS	
2											
4											
6											
8											
10											
12											
2											
4											
6											
8											
10											
12											

Keep this sheet clean, make your reports as brief and complete as possible

A log sheet suitable for stationary plants

are becoming coated with scale. The general efficiency of the engine will fall off, but in most instances the change will be so gradual that comparison of the readings taken one or two weeks before will show no change of any apparent consequence, while reference to readings taken six months before will show a marked change.

Records should contain other important items such as the amount of wear of the working parts, particularly the cylinder liners and rings. Then there should be a record of the amount of solids removed from centrifuges, oil and air filters and deposits found in the engine cylinders, water jackets and crankpits. These deposits may come from the air the engine breathes, the fuel it burns or the oil with which it is lubricated.

In the matter of record keeping the question naturally arises as to how much of our observations we should accidents and troubles, with the solutions described as they were worked out. All this should be correctly dated and made as brief as possible. The daily sheets should have a remarks column in which mention is made of such items as are entered in the diary, so that by referring to the sheets the date of such work may be located and looked up in the book.

No doubt the seafaring engineer keeps a better log than any other class of operating engineer, although it is quite possible that in some plants ashore better methods are employed than are found on ships. The great advantage of ship work is that law and insurance compel correct records. Heavy damage suits or criminal-negligence charges are often settled on the findings of the log. A method common to all ships is employed; modifications are made for the type of machinery only.

INTERNAL COMBUSTION *Engines*

The system followed at sea is briefly as follows: A "scratch-log" is kept in the engine room. The watch engineer enters all temperatures and pressures, the amount of fuel, lubricating oil and other supplies that are used on his watch. He also notes the time of stopping and starting the engines as they are maneuvered, as well as when forced shutdowns are made. Fuel-tank soundings, transfer of fuel from one tank to another, centrifuging lubricating oil, the amount and kind of routine repairs made on his watch, cleaning, painting, sickness of a member of the crew—all go in the "remarks column." There are also the readings of the revolution counters, the average number of revolutions made per minute and the total made per watch, the distance the ship makes by propeller and the average speed by wheel. Weather conditions are noted. A complete report of every accident is also entered, no matter how trivial it may be. This "scratch-log" is filled out in pencil by the engineer on watch, who signs his name to all he writes.

This book is delivered to the chief engineer every day, and he checks over the figures, analyzes the day's performance and makes a copy of it in the "smooth log" with pen and ink. Then he makes a brief report of the average daily performance and enters it on a sheet called the "abstract," which in turn is balanced up and averaged for the voyage. By the end of the voyage he has an inventory ready, giving the amount of stores on hand, and received, the total on hand at the start of the voyage, amount consumed, amount remaining and amount needed for the next voyage. There is also a list of the work and repairs made on the voyage and those needed to be made in port. The original of all this is delivered to the office, and duplicate copies are held aboard ship for reference.

A method such as this works satisfactorily at sea because the ship is a complete and almost corporate organization unto itself and its management is individual while at sea, where most of its time is spent. The seafarer seldom attempts to calculate the cost of power production, and such bookkeeping as he does is for the protection of the ship, himself and the owners. His figures are sufficiently accurate for the accounting department, who will calculate the cost in dollars and cents. His accounts of actual machinery performance are of great value because their completeness makes it possible to review every change in performance, with an absolute certainty that the account will be complete.

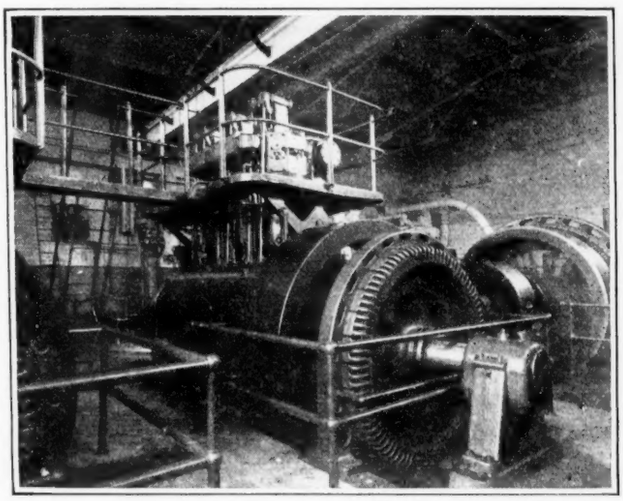
The stationary plant should keep a simpler log. By referring to the specimen log sheet which is given here as a suggestion, we find that all conditions may be noted down with but little trouble. It is assumed that the engine has three cylinders. Six would increase the size of the sheet but not complicate it more. If it were a four-stroke-cycle engine, the item of scavenge-air temperature would be eliminated. A small engine without water- or oil-piston cooling would make that column unnecessary. On solid-injection engines it is not necessary to note injection-air and air-compressor pressures. Not all engines carry oil and fuel pressure. It is then apparent that in some plants the oil-engine log would be a simple one to maintain.

Perhaps some criticism may be made of the time suggested for taking the various readings. Some engineers will declare that readings need not be entered more than once each four hours, while others will declare that hourly readings are necessary. This is largely a matter of opinion. It is not so important to decide how often such readings be noted down as it is to decide once and for all how regularly and systematically they will be taken.

Oil Engine Costs in a Machinery Factory

By G. Grow

DURING the year 1924 at the Painted Post plant of the Ingersoll-Rand Co., there were installed two 300-hp. type PR oil engines, direct-connected to 60-cycle 240-volt alternating-current generators. Previous to this, electric power required for the shops was furnished by steam engines driving direct-connected alternators. The engines operated condensing during the summer months and non-condensing during the winter. When the load increased beyond capacity of the steam equipment, it was decided to install the oil engines. Careful records have been kept of performance of the prime movers, and analysis of these reveals the fact that the cost of operation of the new units is less than one-half that with the steam units.



One of the oil engines in the Painted Post plant

As a typical example of cost performance of oil engines, records covering performance of the two 300-hp. engines for the first four months of 1927 are tabulated on the basis of costs per kilowatt-hour as follows:

Fuel oil, cents	0.505
Labor, cents	.235
Supplies, lubrication, etc., cents	.143
Total average operating costs, cents	0.883

During this period the engines have operated with an average load of 63 per cent. The fuel item cost is based on 6½-cent oil.

EDITORIALS

F. R. LOW, *Editor*

Welding and Kilowatt-Hours

RAPID strides in the application of welding are forecasting changes in many branches of industry. One of the most interesting of these changes is the promise of lower power-generation costs that should follow the full and proper use of this method of fabrication in the industrial-power plant.

Unit costs of power generation are made up, to a considerable extent, of fixed charges on buildings and equipment. Anything that reduces building and equipment costs reduces the fixed charges on them and, therefore, reduces the cost per generated kilowatt-hour. Welding can be used to reduce these charges in two ways.

Fabrication of equipment by welding makes great savings. Parts formerly made of cast iron can be made of steel plates, sheets or shapes at about one-third the cost per pound of metal used. And since steel is stronger than cast iron, fewer pounds of metal need be used. Consequently, equipment can be made both lighter and cheaper.

Buildings can be made cheaper by the use of welding: First, because the equipment in them is lighter when welded, and hence needs a lighter foundation; and, second, because welded steel frames can be used in place of riveted steel frames at a saving in metal weight and hence in building cost.

These savings in building and equipment cost, when realized to the fullest possible extent, will make an appreciable difference in the cost of power generation. Thus industries that so use welding will be better able to use the product of industrial power plants. The obvious conclusion is that power plant engineers will benefit by the increased use of welding and should, therefore, give it their enthusiastic support.

Co-operation Between Central Station and Isolated Plant

"EVERY two years the central-station accountants come to our plant and go over our books thoroughly," was the recent statement of the plant superintendent of one of the largest industrial plants in the country. "If they find that they can give us power at a rate that will permit us to shut our turbines down and only generate steam," he continued, "we'll be glad to make the change; but so far they find that we can produce current cheaper than they can."

These remarks indicate a form of co-operation between central station and isolated plant that might, with profit, be indulged in more frequently. If, instead of listening to the siren song of high-pressure salesmanship or the promptings of stubborn prejudice, all decisions between these two sources of electric energy were made simply on a dollars and cents basis, it is likely that there would be less shifting about, first from one to the other and then back again.

But in reaching a dollars and cents decision, a generous measure of caution must be used to see that the true cost of isolated plant power is known. In the first place, every legitimate charge for operation and overhead must be made against the power plant, and in the second place, full credit must be given it for services other than electric current generation, that it supplies to the manufacturing departments. And, finally, the expense of providing these services, if the current is generated elsewhere, must be given full weight. It is only by having all these facts available and balancing them against the lowest price that the central station can offer, that a correct decision can be reached. This means quite a burden of bookkeeping, but it is worth it.

Coal Dust

COAL DUST is much in evidence these days in discussions on pulverized coal. Such dust is discharged through drier vents, through the vents of mill cyclones and from the vents of transport systems. Only exceedingly fine dust is lost in this way. While its amount by weight is often relatively small as compared to the total tonnage of coal handled, nevertheless it dirties the roofs, pollutes the air, disfigures power house buildings, and thereby makes itself a nuisance.

Many arrangements have been tried to catch this fine dust. Bag filters seem to be the most promising method, but these are large, troublesome to operate and expensive. It may be possible to overcome this nuisance by a plan now being tried abroad of using all such vents for primary air supply, thus discharging the dust into the furnace where it rightly belongs. There may be difficulties in piping to avoid explosion risks. However, this seems a sure and satisfactory way of getting rid of the nuisance.

There is another problem connected with the use of pulverized coal dust in power plants that has not received

the full study that it deserves. Most operating men do not fully appreciate when an air-coal-dust mixture is explosive and when it is not. What density of coal dust in the mixture makes it dangerous? What is the relation of coal-dust size to ease of ignition in the air? What means of ignition most readily start explosions? For instance, what are the relative liabilities from open flames, from electric sparks and from electrostatic discharges? What special safety precautions must be taken to prevent explosion? What is the liability of a dust explosion in coal dumpers or Bradford breakers?

These factors should be appreciated by every operator who has plant safety in mind. When all contributing factors are known, they should be drilled into all subordinates so that explosion risks may be lessened. Possibly the work of the Bureau of Mines with coal-dust explosions in mines may offer an answer to all these questions. If so, let us have it presented in a form that will impress the facts on the minds of our power engineers.

Another Chapter In the Chicago Diversion

WATER rights have formed the subject of many legal struggles in this country, but none has been contested with greater persistency than the diversion from Lake Michigan into the Chicago Sanitary Drainage Canal and then through the Illinois River into the Mississippi River. By the original treaty Chicago was allowed to divert 4,167 second-feet, but this had been increased to about ten thousand second-feet, when early in 1925 the United States Supreme Court granted the United States an injunction restraining the Sanitary District of Chicago from diverting more water than allowed by the treaty.

Shortly after the restraining injunction Secretary of War Weeks granted a temporary permit to Chicago, which expires at the end of 1929, allowing a diversion of eight thousand five hundred second-feet. The granting of the temporary permit was followed by the Lake States, with the exception of Illinois, bringing suit to prevent the increased diversion.

Another chapter in this controversy was written recently, when Charles Evans Hughes, as special master in this case, submitted a report to the United States Supreme Court in which he held that the present diversion permit, issued by the Secretary of War, was valid, but that the State of Illinois and the Sanitary District of Chicago have no authority to make or continue to make the diversion without the consent of the United States.

This report, outside of being a masterly interpretation of the constitutional rights of the United States Government over those of the states or other interests, and presenting a voluminous mass of complicated legal technicalities and evidence in a form that may be easily comprehended, does little more than confirm the 1925 decision of the Supreme Court, that the authority of the United States is supreme over navigable waters. In the light of these findings it would seem that the Lake States have no legal right to bring suit against the Sanitary District of Chicago. This, however, is something on which the Supreme Court has yet to render an opinion.

Notwithstanding these long drawn out legal battles, the question of the Chicago diversion is far from being settled. What effect it may have on the lake levels and on navigation, may be corrected by building regulating works to control the lake levels. This, however, cannot compensate for the loss of power in the Niagara and St. Lawrence Rivers. Eight thousand five hundred second-feet in these rivers will produce over four hundred thousand horsepower. This water may not at this time be of serious moment to New York State, but eventually it will be. The question that must be settled is whether this water is of so much greater importance to Chicago for sanitary purposes as to justify its diversion out of its natural course, where it is of great economic value for power generation.

Shortsighted Curtailment

THE Government's policy of retrenchment in expenditure has been generally commendable, but, as often happens in such cases, it may sometimes be carried to the point of shortsightedness. This appears to be the situation with regard to the expenses of government employees attending technical meetings and conventions Some time ago there was a movement to withdraw all appropriations for such purposes, but upon the remonstrance of certain department heads these appropriations were restored in greatly curtailed amounts. For instance, one of the most important technical bureaus has at its disposal only two thousand dollars, yet its activities cover a number of fields in which several of the more important national engineering and scientific societies hold annual and semi-annual conventions, as well as regional meetings. With this absurdly small appropriation this bureau has found it necessary to withdraw from important technical society contacts some of the leading experts and soundest counsellors in their field of engineering and industry.

Many government departments are doing valuable work of a technical nature, and one of the best ways for industry to profit by this is to know and mix with the men who are doing the work. No better opportunities are offered than attendance at conventions. Conversely, such contacts broaden and make more useful public servants of the government's representatives.

While it is understandable that expenditures of public money have to be surrounded with certain restrictions, there is no reason why business reasoning should not be applied in arriving at these restrictions.

IDEAS *from* PRACTICAL MEN

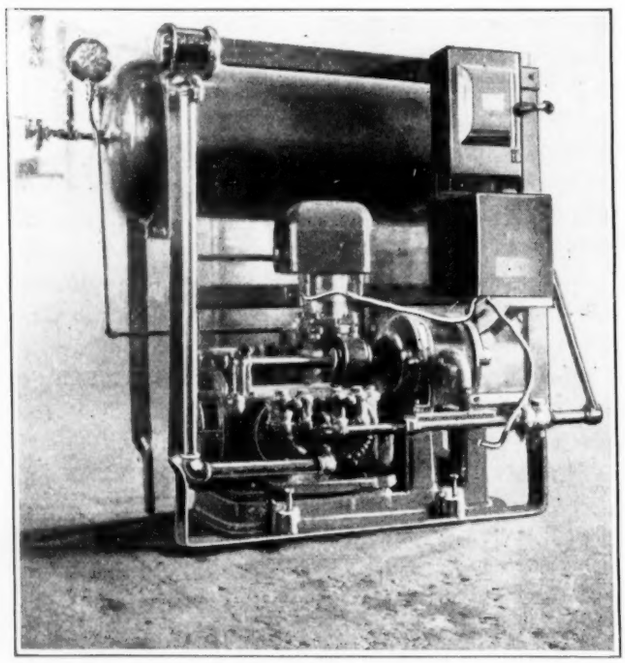
Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Portable Air Compressor Outfit

WE ARE operating a power plant of 500 kw. capacity. The station was equipped originally with only such apparatus as was essential for the operation of the generating equipment. From time to time conditions arose where compressed air would have helped materially if we had had a source of supply.

After repeated requests the management finally agreed to purchase an outfit, but limited us as to the amount of the expenditure. The money allowed was not sufficient to purchase any standard compressor of the proper capacity. We therefore decided to build our own.

A street-car air compressor geared to a 2-hp. induction motor was purchased, together with a 16x48-in. reservoir, governor, safety valve, gage, starting switches, etc.



Portable air compressor outfit

This apparatus was mounted on a $\frac{5}{8}$x2$\frac{1}{2}$-in. iron framework so as to occupy a minimum of floor space. When completed, the height over-all was 4 ft. 1 in. and the base 5 ft. 1 in. by 29 inches.

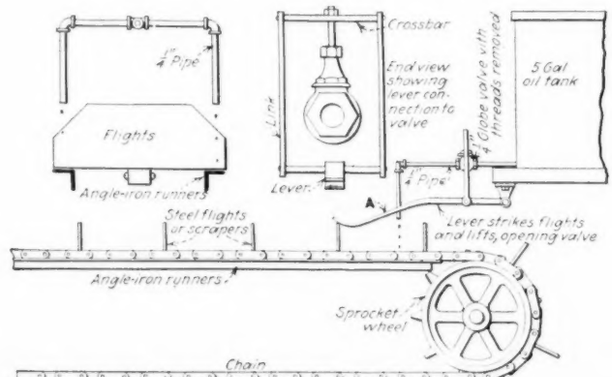
We have found extensive use for this outfit since it was put into service. It is also used by our operators to blow out the substation apparatus. G. WILLIAMS.

New York City.

Automatic Lubricator on Drag Conveyor Eliminates Squeaks and Reduces Wear

IN ONE of our plants we have a chain drag conveyor for distributing the coal to the bunkers. This has been a source of annoyance to us owing to the continual squeaking and the necessity of renewing the angle-iron runners every few months.

To overcome this trouble the day engineer at this plant



Arrangement and details of oiler for drag conveyor

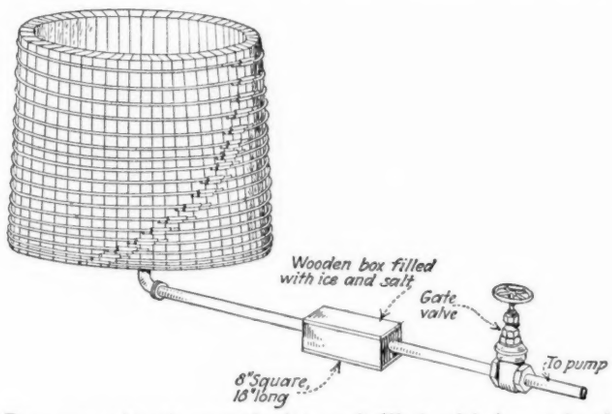
made an automatic oiler that would admit a few drops to the runners while the conveyor was in operation and automatically stop when the conveyor was idle. Waste oil or filtered oil is used, and five gallons will lubricate the conveyor more than two weeks. The general arrangement and details of the oiler are shown in the illustration.

Wilkes-Barre, Pa. THOS. M. STREET.

Freezing a Suction Pipe to Make Repairs

IN OUR factory the raw material is thrown into a large vat, where it is crushed by two roller stones. The vat is kept filled with water, and the crushed product rises to the surface and overflows into a classifier. In the classifier the fine and the coarse are separated. The fine is pumped into a large overhead settling tank. A pipe line extends from the bottom of the tank to a diaphragm pump, which discharges the solution to a filter, where the moisture is extracted. The product is then transported by a screw conveyor to an oil-fired rotary drier.

Some time ago the diaphragm pump failed to handle the solution. The pump was taken apart, but nothing was found wrong with it. The trouble was finally located at the gate valve in the pipe line between the pump and the bottom of the tank. The next question was how to overhaul the valve without emptying the tank. Many suggestions were offered, the most practical one being



Box was placed around pipe and filled with ice and salt

finally adopted; namely, freezing the pipe line between the valve and the settling tank.

Accordingly, a rectangular box 8 in. square and 18 in. long was made and fitted over the pipe as shown in the illustration. The box was packed with crushed ice, and before the lid was nailed on a large amount of salt was added. The purpose of the salt was, of course, to lower the temperature of the mixture of the solution below that of the ice alone. Ice and salt were added periodically for a period of two hours, and at the end of that time the solution in the pipe was frozen solid. The bonnet was removed from the valve, and a piece of wood was found blocking the pipe. After the pipe was cleared, the bonnet was put back and the box was removed from the pipe. Then the frozen section of the pipe was heated with a blowtorch, and once again the pump was placed in operation.

New York City. G. T. MICHEALS.

Torque Motor Reverses During Test

A GROUP of small 220-volt three-phase torque motors of the type used on alternating-current elevator controllers for operating accelerating switches, brakes and other equipment, was being tested by connecting each motor to the line through a three-pole knife switch. The clips on one pole of this switch became spread apart so that two blades made contact before the third. The interesting discovery was made that when the switch was partly closed, the motor generally started in the reverse direction. Then, when the switch was pushed to the fully closed position, the motor would stop and start in the normal direction.

In an attempt to find the explanation, the switch was repaired and paper inserted between one blade and its clips, which resulted in the motors starting in a reverse and definitely proved that no actual contact was being made. This action is explained in the following:

A three-phase induction motor is not self-starting on single phase, but will run in either direction if started. A very small torque will start it, and it is believed that the electrostatic capacity of the switch blade and clips, not quite touching, caused a condenser effect sufficient to produce a weak leading current to excite the other two phases and run the motor in the reverse direction. The leading current would have a reverse direction to the normally lagging current of the motor and would produce an effect equivalent to interchanging two line wires and would cause the motor to start backward.

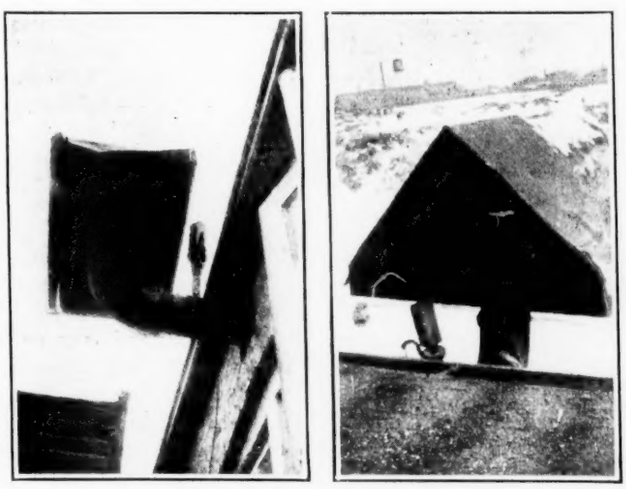
No appreciable starting torque was developed by the weak fields set up, and was of little practical significance, but the incident was puzzling for some time. Such motors are designed to rotate slowly for a few revolutions and not to run at any considerable speed. Their impedance is high at starting and the current small. The weak leading current was, therefore, greater in proportion than in other types of motor and had a more noticeable effect. K. M. WHITE.

Chicago, Ill.

Have You Anything Like This in Your Plant?

THE accompanying illustration might be shown as "A story without words" to the observant. However, it might be well to add that a condition as inconsistent as that shown, with regard to installing accessory equipment, is not infrequently observed around power plants. Things of this sort do not always indicate a lack of knowledge of what is more fitting, but they do indicate that the man on the job has got into a rut and lacks the ability to view things close at hand with a critical eye.

A short distance to the rear of the filter may be seen a louver, from which a cloud of dust and lint is dis-



Filter located close to dust ventilator and whistle

charged during operations. The filter intake is at just the right height to catch the dirt blown off the roof, and the closeup on the whistle side shows what happens when the whistle is blown. The pipe connection for the whistle was taken off at a point where the accumulation of oil and dirt lodged, and four times a day the mess was ejected with the result shown.

Probably the salesman should have suggested a more suitable location for the filter, but in these days of "high-pressure one-call go-getters," they have little time in which to follow up the operation of the equipment sold.

Chicago, Ill. S. M. QUINN.

COMMENTS *from* READERS

What Caused the Pitting on the Journals of a New Turbine Generator-Unit?

REFERRING to the inquiry of J. W. Baker in the Sept. 27 issue as to what caused the pitting on the journals of a new turbine-generator unit, my opinion is that electrolysis caused all the trouble, due, probably, to a small amount of current leaking through to the generator shaft or through the frame of the generator. The possibility of more or less moisture getting into the bearings, causing an arcing effect between the shaft and bearing, would naturally cause a pitting action to take place. The pitting being worse on the bearing next to the generator end is also an indication of electrolysis.

I had an experience similar to that of Mr. Baker, with the exception that the pitting took place in the steam and water lines. By checking up my electric lines, I found one of the wires grounded to the conduit, which in turn was grounded to the water lines. I insulated the wire and have not been bothered any more with pitting.

Buffalo, N. Y. JOHN W. FERGUSON.

Based on past experience the pitting mentioned by Mr. Baker looks to me like a case of a grounded winding in the rotating field, and the fact that the pitting is more pronounced at the generator end is strong evidence supporting that conclusion. R. C. ECCLESTON.

Ridgway, Pa.

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Admits Editorial Helped Him

THE editorial in the Oct. 11 issue entitled "Don't Forget the Spare Equipment," certainly started some action in our plant.

The capacity of the plant we are operating is not so large as the average, but we have endeavored to guard against a service interruption, with a minimum outlay of money. Duplicate apparatus has been installed where the expense was not prohibitive, and each piece of apparatus is operated alternately for a certain period of time and repairs are made when needed. We have two engine-driven generating units, either of which will handle the average load, but during certain periods of the day both machines are required for the peak load. The same conditions exist with our step-up transformers. Spare generating and transformer units cannot be installed because of lack of space and funds.

In view of this condition we stocked up with a liberal supply of spare parts for this apparatus, especially coils. These coils have been in our stockroom for a number of years. Upon reading the editorial, we inspected them and made insulation tests, and to our amazement it was found that the insulation had deteriorated to such an extent that they hardly withstood normal voltage. This has left us in rather a serious predicament, as the old coils had to be scrapped and new ones ordered.

All spare equipment will undergo a systematic inspection and test on a definite time basis in the future, whether it is in the plant or in the storehouse, in order to avoid a similar occurrence.

We thought we were safe by having the storeroom stocked with parts and did not realize that they were deteriorating. It would be advisable for other plants to check their perishable spares. J. FREEMAN.

New York City.

* * * *

Why Do Boilers Drum?

REFERRING to the inquiry of E. D. Hewlet in the July 5 issue and the comments of H. M. Toombs and Earle S. Nason in the Nov. 8 issue, I should like to add my comments.

I have experienced the drumming in a single-end wet-back Scotch marine boiler on one ship to which I was attached. This vibration always took place immediately after lighting the fires, when the boiler was clean and the water cold, and it was especially bad with open drafts. We overcame it by putting on the ashpit doors and shutting in the damper.

My theory is that when the fire burned up with heavy draft, the hot distillates came in contact with the cold furnace and were cooled below the combustion point, after which they were turbulently mixed with the hot gases in the combustion chamber, where a series of explosions took place in rapid succession, which set up a harmonic vibration in the whole boiler and surrounding buildings.

Philadelphia, Pa. GEORGE O. DAVIS.

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What Do You Know?

IN THE answer to question No. 7 in the "What Do You Know" column of the Nov. 1 issue, the explanation is only partly correct. While it is true that there must be a balance maintained between the force applied and the adhesion of the wheel to the rail, the reason for throttling the steam to the cylinder at the moment of starting is to prevent what is usually termed in railroad parlance as "rough handling."

On freight trains, because of the amount of slack between cars, it is important that care be exercised to prevent the pulling out of drawbars or breaking knuckles; in fact, the train should be started one car at a time until the "slack" of the entire train is "out," when the throttle may be opened full or to a point effecting the balance between the adhesion to the rail and the power exerted; otherwise the wheels will slip. Because of various rail conditions, such as a light, sprinkling rain or frost, it is necessary to provide sand on the locomotive, to be applied

to the rail to assist the wheels in maintaining their grip on the rail.

What applies in the handling of the locomotive in freight service is equally true in passenger service except it is greatly modified because of the length of the train and the minimum "slack" between coaches.

Chicago, Ill. F. C. FOSDICK.

I have been much interested in the questions and answers that have appeared in *Power* under the heading, "What Do You Know?"

With reference to question No. 10 in the Oct. 18 issue, it is stated that the motor-driven centrifugal pump must handle the maximum capacity, the assumption being that regardless of load on the boiler, the capacity would be the same. I suggest a study of a characteristic curve of a boiler feed pump which would show the effect on the horsepower for changes in pressure or in capacity, as would be the case where an excess-pressure regulator is used.

If the comparison made had referred to a rotary pump and a steam pump, it would have been correct, but in this particular case comparing the operation and horsepower required on the steam pump and centrifugal pump will, it seems to me, leave an erroneous impression in the minds of many readers. T. J. BARRY.

Pittsburgh, Pa.

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Get the Facts—Then Go Ahead

WITH reference to the letter by F. V. Wetherill in the Sept. 27 issue, "Get the Facts—Then Go Ahead," I should like to give some of my experiences bearing out what he has already written.

Some years ago I started a boiler house which was used to furnish steam for a paper mill. We had two vertical water-tube boilers, and the only method we had of checking performance was by timing the strokes of the feed pumps.

After we got the plant under way, I asked for a draft gage and a couple of flow meters, and while this request was being considered, I improvised a couple of draft indicators out of a piece of board, some tubing and a scale. As there was some question of the steam quality, I installed a throttling calorimeter.

We had the returns from the paper machine and good lake water for boiler feed, and as we had exhaust steam available from the forced-draft turbine, I asked for an open heater. This was not regarded with such disfavor as the suggestion about meters, as I presently discovered.

There happened to be an old open heater in the scrap pile at one of the other plants, so we had that brought over and set up. It was not exactly a piece of modern equipment, but it answered our purpose, and the temperature of the feed water was raised from around 75 deg. to 150 deg.

The paper machine got under way and began to come up to production. This raised the steam demand to the place where we had to force the boilers and the brickwork began to suffer, necessitating frequent repairs. This attracted the attention of the management, and I was called on the carpet. When I arrived in the office, they were all there, the great and the near great, among whom I recognized a prominent designing engineer. This gave me a little courage as I realized that there was one who would understand.

When they asked the cause of the trouble, I replied that it looked to me like excessive load and no spare boiler to permit us to keep the other boilers in shape. To this they replied that they had been advised that the boiler capacity was ample. I knew that the plant was running under heavy load conditions, but it was possible that the demand was heavier than they anticipated. Then they said that I should be in a position to know this. I replied by placing my requisitions for meters, etc., on the table.

This seemed to start things, and I told them just what I thought of the situation; that one could not remedy troubles until one knew what was wrong; that I could not tell what the boilers were doing nor did I know the steam demand. There was quite an argument over this, and the engineer advised them that he could not help them in the absence of reliable data.

To cut a long story short, we got the meters and boiler conditions righted themselves. The lesson was so well learned that, when this same mill built a new boiler plant, nothing that would enable us to know what we were doing was omitted from the original order.

Port Arthur, Ont. R. G. EDWARDS.

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Conductivity Methods of Measuring Condenser Leakage

I HAVE read with considerable interest the article entitled "Conductivity Methods of Measuring Condenser Leakage," by Henry C. Parker and Willard N. Greer, which appeared in the Sept. 27 issue. Digby's instrument referred to as his "conductance meter" or modified "megger," has been known for several years as the "Dionic Water Tester," and it seems to me that several points brought up in the article deserve consideration.

Possibly the apparatus, as originally used by Digby and Biggs, was "crude," as stated in the article, but I have no doubt the authors have used crude apparatus, roughly assembled, in preliminary investigations, and if results were found to be promising, made refinements later. This is exactly what has been done by the manufacturer of the Dionic Water Tester.

In the tests made by Digby and Biggs, laboratory distilled water was used, instead of a sample of condensed steam, in obtaining data for drawing leakage curves. While this involved some error, a forward step was made. In this connection we must recognize the fact, as stated by the authors, that until recently there was no good practical way of obtaining a sample of condensed steam from a condensing unit. Messrs. Digby and Biggs faced great difficulties in developing an outfit that would give correct indications of the conductivity of the solution under test. How these difficulties were overcome will not be discussed here, except that having to do with the back electromotive force of polarization as referred to in footnote 7 of the article by Parker and Greer.

With bright platinum electrodes a fair average value of the back electromotive force for such weak solutions as come within the range of the tester previously referred to, has been found to be 2 volts. The testing current is supplied by a small hand-driven direct-current generator which supplies 100 volts, kept constant by means of a governor. In calibrating the indicating meter against standard resistances, an opposing electromotive force of

2 volts is used in the circuit which ordinarily contains the solution to be tested. Under these conditions a considerable departure from the average value of 2 volts back electromotive force of polarization has but little effect on the accuracy of the indications. The error involved, if any, will be less than that which may result by assuming an average factor of 91.5, as recommended by Parker and Greer, for conductance of river water.

As a further refinement, the tester has automatic compensation for temperature of the solution under test. This is desirable as the temperature effect on resistance is approximately 1.2 per cent per degree, at 68 deg. F. (2.2 per cent per degree at 20 deg. C.). The apparatus described in the article by Parker and Greer and used to obtain the data given, does not have the advantage of automatic temperature compensation.

I might suggest that anyone interested in the testing of condenser leakage refer to *Mechanical Engineer* for November, 1925. Under "Code on Instruments and Apparatus" there is given a "Preliminary Draft on Chapter 21, dealing with Condenser-leakage Tests." This outlines in detail the up-to-date practice for determining condenser leakage. Section E deals with the electrolytic conductance method and lists the tester referred to as an approved instrument for such tests.

Philadelphia, Pa. WILLIAM B. CREAGMILE,
With James G. Biddle.

* * * *

The Value of Reading

I HAD occasion to visit a plant recently where the main power unit was a Diesel engine. After the principal object of my visit had been accomplished, the engineer called my attention to a sharp metallic knock that was coming from the cylinders, remarking that it had puzzled him for some time and asked me if I could give him the reason. Let me say right here that my knowledge of Diesel engines is limited, but for various reasons I did not want to confess it right then.

While I was "stalling" and trying to figure out the reasons for the knock, my eye fell on the Oct. 4 issue of *Power*, lying on a corner of his desk. From its clean and unrumpled appearance I knew that he had not read it much if any, and that I could save my reputation by that fact, so after a few minutes of "deep" thinking I told him that the knock was no doubt due to a too early injection of fuel, and by checking up on that and making the right adjustment he would remove the cause.

Several days later I met him and he told me that I was right; he had adjusted the valves and the noise had stopped. This brings out Editor Low's Foreword in the Oct. 4 issue "Value of Reading," for if that engineer had read the "What Do You Know" column on page 510 of that issue with the answers, he would not have to ask the reason for the knock in his engine, but I would have lost some prestige. THOMAS M. STREET.

Wilkes-Barre, Pa.

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Noise

I READ with considerable interest the "Foreword" in the Nov. 1 issue on "Noise." Have you any suggestions to offer for a boiler shop?

STARR H. BARNUM, Vice-President,
New Haven, Conn. The Bigelow Company.

Answers to What Do You Know

The questions are on page 878

Ans. 1—With a symmetrical rocker and a valve with equal laps the port openings will be equal, but the piston positions at cutoff will be very unequal at the two ends and equalization of the cutoff must be at the expense of the lead. By the use of a bent rocker an irregularity may be purposely introduced into the valve motion that may be made to equalize the cutoff without interfering with the equality of the lead, which is of greater importance than equality of port opening.

Ans. 2—A $\frac{1}{4}$-in. reduction of diameter of the eccentric, without equal reduction of the bore of the eccentric strap, would give rise to $\frac{1}{8}$ in. lost motion at each end of the stroke of the eccentric rod, with a corresponding reduction in the length of valve travel. But if the new eccentric straps are bored out to fit the eccentric and the length of the eccentric rod, measured from the center of the eccentric to the pin in the end of the rod, is made the same as it was before reduction of the diameter of the eccentric, then there will be no change from the original travel of the eccentric rod pin and the original length of rocker arms and valve rod will give the original valve travel.

Ans. 3—The temperature will not exceed 600 deg. F. and in many engines is as low as 500 deg. It is less than in case of a four-stroke-cycle engine by reason of the mixing of the scavenging air with exhaust gases.

Ans. 4—For a given draft and given size of flue the volume of furnace gases that can be carried off depends on the least cross-sectional area of the smokepipe connection. Sharp corners and bends cause eddies which give rise to soot deposits. These smooth out the channel and usually result in so much higher average velocity that there is a greater volume of gases discharged with the reduced cross-sectional area. Generally speaking, removal of the deposits will not improve the draft unless it results in enlarging the smallest cross-sectional area.

Ans. 5—If the coils are kept filled at full load, the slightest increase in heat flow will cause the ammonia to boil violently and slugs of liquid will be carried over to the compressor. It is often noticed that coils are completely emptied of liquid by violent boiling. This does not occur at part load and the coils can be carried full.

Ans. 6—The elastic limit is the value of the unit stress beyond which, as the stress is increased, the ratio of elongation to unit stress increases.

Ans. 7—Slide-valve engines as a rule are equipped with a one-piece cored cast-iron piston.

Ans. 8—The condensate flows into the conical base of the pump, and when the conical-ended plunger nears the end of its down stroke, the water is forced in a thin stream through ports in the pump barrel into the space above the piston. This water spray carries the air with it, and on the upstroke of the piston the water and air are forced out through discharge valves.

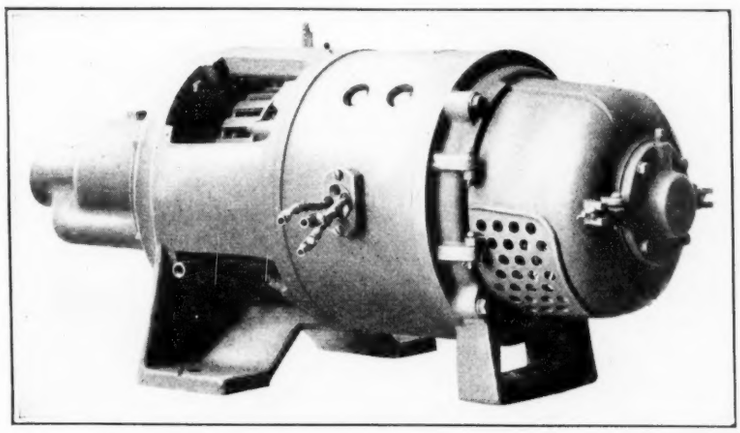
Ans. 9. This is caused by moisture in the steam being thrown out from the ends of the blades by centrifugal force.

Ans. 10—When the power factor is about 0.71, or when the phase angle between the current and voltage is equal to 45 degrees.

New and Improved EQUIPMENT

Westinghouse Builds Small Turbine-Generator Unit

A DIRECT-CONNECTED turbine-generator unit having a rating of 3 kw. has been recently placed on the market by the Westinghouse Electric & Manufacturing Company. This apparatus has been developed to meet the growing demand for a high-grade small non-condensing steam-turbine generator lighting set for use with oil-well rigs, steam shovels, isolated pumping plants and for general outdoor construction work. They are also suitable for marine application and can be installed aboard tugboats, lighters, yachts, river craft and also for stand-by service in port on the larger type vessels. The generator coils are specially impregnated, and all parts requiring such protection are heavily sherardized to meet the conditions of applications of this nature.



Three-kilowatt direct-current turbine-generator unit

The unit is capable of generating 3 kw. at 125 volts direct current when operating under steam conditions commonly encountered in its projected field of application. The well-known Westinghouse re-entry type single impulse-wheel turbine is used and is overhung on the end of the generator shaft.

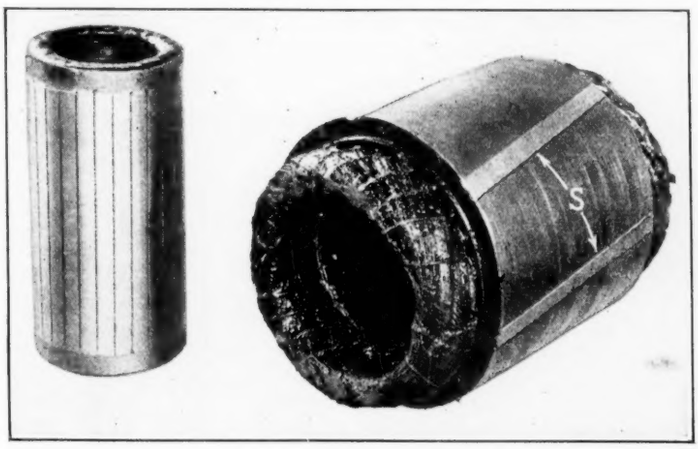
The turbine cylinder is bolted to a flange on the generator frame. Extra large ball bearings support the generator rotor. The turbine rotor is a solid forging, and the buckets are milled on the inside periphery of an overhanging flange which is integral with the disk proper. It is pressed on a tapered extension of the generator shaft and secured with a locknut. To insure against short-circuiting of the windings, due to steam or water entering the generator end of the unit, the turbine and generator ends are completely isolated.

The steam nozzle and reversing chamber are contained in a single block which is bolted to the inside of the turbine cylinder. The speed of the unit is regulated by a flyball, centrifugal, shaft type governor, which is carried in a heavy case bolted directly to the rotor disk. This governor is equipped with specially hardened steel knife-edges and blocks and acts directly on the valve stem, thus eliminating all levers. A sealing gland is furnished to prevent the escape of steam around the rotor shaft where it passes through the cylinder. It is of the labyrinth design, employing piston-type metal sealing rings.

All parts are readily accessible for inspection by simply removing the turbine and the generator end covers. No expert attendance is required for its operation and maintenance, as there are no delicate adjustments to make and the unit requires practically no attention while in operation. To insure against destruction of the machine and injury to the operators in case of accidental overspeeding, protection has been provided in the form of an overhanging flange of the turbine rotor. When the unit reaches a predetermined speed, which is well below the rupturing point of any of the parts, the flange fills the clearance space in the cylinder, thus establishing a rubbing contact. This contact causes a powerful braking action that restrains the speed of the machine to within safe limits.

New Shell-Type High-Speed Squirrel-Cage Motor

The Lincoln Electric Company, of Cleveland, Ohio, has recently placed on the market a squirrel-cage motor for use in various kinds of wood-working machinery and other types of machinery requiring high-speed motors. This motor is of the so-called shell type, an all-welded design, and is made to the standard dimensions of the trade. It is supplied in two sizes, 3 to 5 hp. The 3-hp. unit has an external diameter of 6.5 in. and an external length of 4.5 in. The 5-hp. size is of the same diameter



Rotor and stator of welded shell-type motor

as is the 3-hp. motor, but has an external length of 6 inches.

Both motors are built for operation on either a two- or a three-phase, 60-cycle circuit and have a speed of 3,600 r.p.m. The stator is composed of laminated sections which are arc-welded together. The welding is done while the shell is under pressure and is placed in six transverse slots, such as at *S* in the figure. The rotor is also entirely arc-welded and provided with either a straight or tapered bore.

There is a definite advantage to this type of construction. The welding does away with the necessity of a solid shell about the laminations and also replaces the conventional rivets. Thus, the amount of active field material is kept at a maximum. The effect of this is to increase the magnetic flux and allow more copper to be used in the slot. As normally used, the stator is secured in the frame of the driven machine and the rotor is mounted on the tool shaft.

Circulator for Hot-Water Heating Systems

THE accompanying illustrations, reproduced from *The Engineer*, show a circulating apparatus for hot-water heating systems recently introduced by Holden & Brooke, Ltd., of Manchester, England. The apparatus comprises essentially a motor-driven centrifugal pump the cover of which can be removed without breaking any hydraulic connections and without disturbing the motor or coupling.

The base of the pump is flanged and

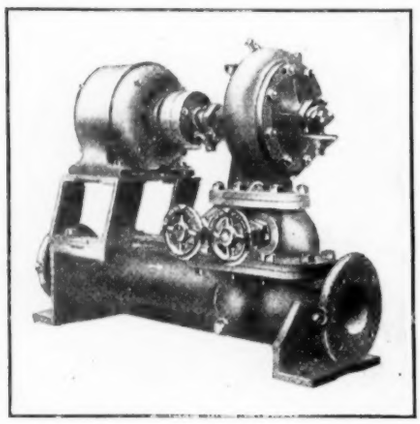


Fig. 1—Assembly of hot-water circulator

ported to correspond with a similarly shaped flange on the main base casting, which, instead of being in the form of the usual bedplate, takes the form of a standard length of the hot-water piping in the circuit. In this pipe bedplate is included a non-return valve *A*, which hangs off its seat when the pump is not running. The suction and delivery ducts to and from the pump lead from either side of this valve, so that when the pump is put into operation, the valve is at once closed and held closed, and the water is caused to circulate through the pump.

In case the pump accidentally stops, the valve again falls open and allows the normal gravity flow to continue. It

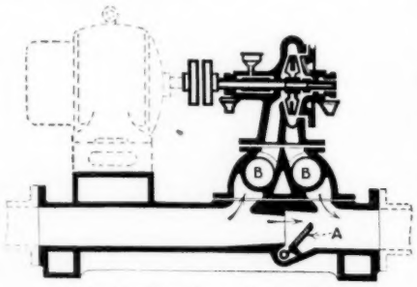


Fig. 2—Section of circulator

will be noted that each duct in the base casting contains a plug cock *B*, which acts as an isolating valve for the pump.

Hofft Combined Refuse Conveyor and Feeder for Boiler Furnaces

FOR best results in burning refuse in a boiler furnace, as with any other kind of fuel, it is essential that the refuse be fed continuously in a uniform stream. It is also essential that means be provided to prevent flooding of the furnace with the fuel and to limit the amount of

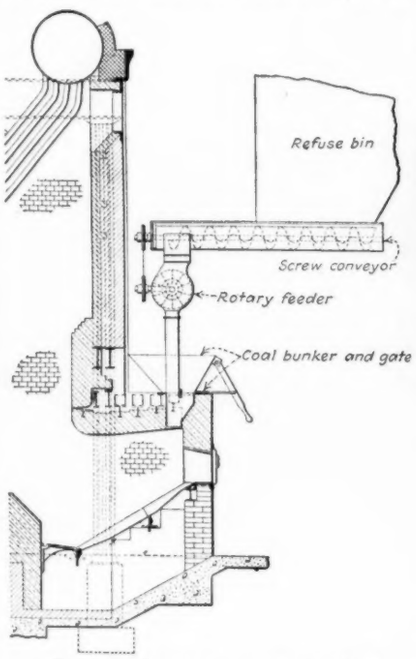


Fig. 1—General arrangement of conveyor and feeder

excess air admitted to the furnace with the fuel.

With a view to providing a feeding device to meet these conditions, the M. A. Hofft Co., Indianapolis, Ind., has brought out the combined conveyor and feeder shown in the illustrations. Fig. 1 shows the general arrangement of the machine and Figs. 2 and 3 the details of the feeder and conveyor drive.

The unit consists essentially of duplicate screw conveyors for conveying the material from the bin to the feeders, rotary feeders for discharging the refuse

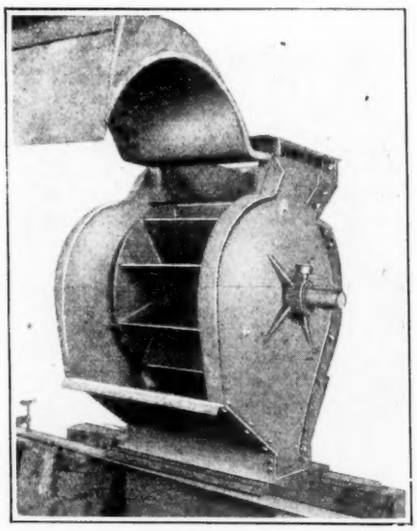


Fig. 2—Details of rotary feeder

continuously and uniformly into the furnace, and the necessary driving gear.

One conveyor and feeder form a unit, and two units are mounted on a structural steel frame with the driving gear placed centrally between them. Each conveyor is driven independently from

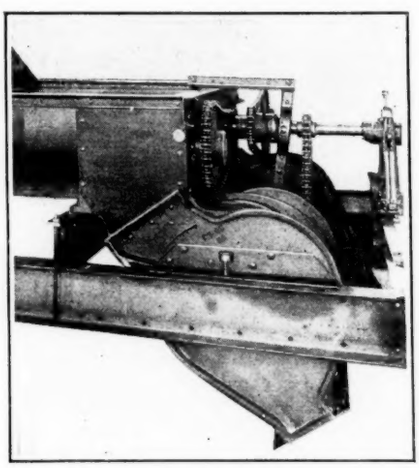


Fig. 3—Assembly of two conveyors and feeders with driving gear

the driving shaft by means of sprocket wheels and roller chains, while the two feeders are driven through a single chain and miter gears. Clutches are incorporated in the conveyor drive to allow the conveyors to be operated independently or in parallel. The discharge pipes from the feeders are carried through a coal hopper which is provided with a gate for regulating the amount of coal fed to the furnace with the refuse

Portable Compressors Perform Emergency Shop Service During New England Flood

IN THE accompanying illustrations are shown the results of the flood at Claremont, N. H., to the main works of the Sullivan Machinery Company, necessitating the use of a battery of portable air compressors to supply emergency shop service.

As may be known, Claremont, situated about four miles from the Connecticut River, sustained but little damage from the severe floods of the first week in November. The Sugar River outlet of Sunapee Lake, which caused much damage at the town of Newport, eight miles farther upstream, flowed through Claremont without doing serious harm, as the fall of the stream through the town is rapid and the banks for the most part high. The stream passes directly through the plant of the Sullivan Machinery Company, the machine shop assembly department and testing department being on the south bank, while the foundry, pattern shop, storehouses and power house are on the north bank.

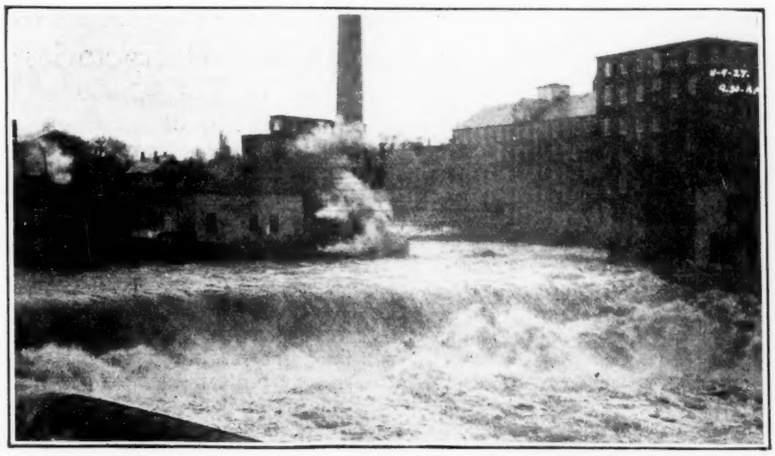


Fig. 1 — Water 5½ ft. deep over crest of new concrete dam on Nov. 4

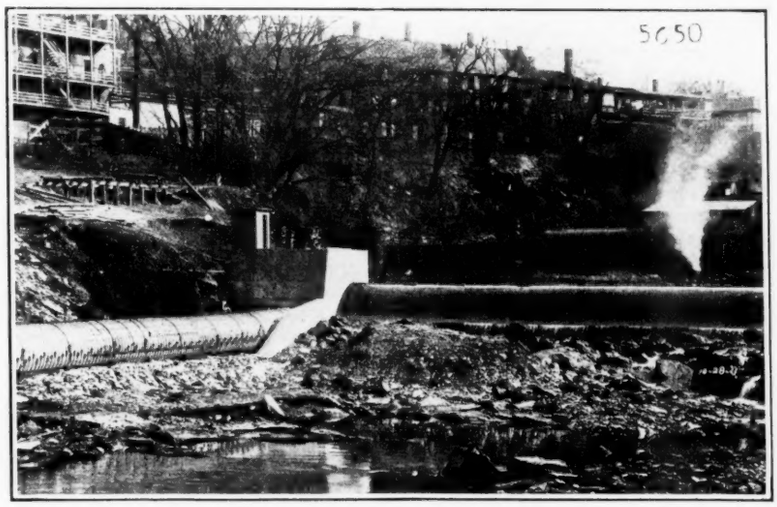


Fig. 2—Wreck of suspension foot bridge across Sugar River and the damage to the overhead pipe lines

The company had just completed the removal of an old dam at the foot of its property and the construction of a new concrete dam to replace a timber structure at the upper end of its holdings. On Nov. 3 water was turned into its new penstock, shown in one of the illustrations. On the next day the maximum flood height was reached with water pouring over the new dam to a depth of 5½ ft. above the crest. The stream undermined the foundations of an old suspension foot bridge just above the bridge, carrying steam, hot water and compressed-air pipes from the power house to the main plant. The bridge fell into the stream and was washed away. Its cables on the south side rested on the pipe lines mentioned, which are carried on an overhead trestle at that point. Before the lines could be supported and the weight of the bridge released, the pipes burst and shut off the various services to the main buildings.

During the period of repair the entire plant was supplied with compressed air by a battery of portable compressors brought from the company's warehouse and connected up on the testing floor of the compressor shop. Seven four-cylinder, 220-ft. units driven directly by Buda four-cylinder gasoline engines were used. The receiver of each compressor was hooked up to the main air supply line, and all seven machines ran steadily for three days, supplying 1,500 cu.ft. of free air per minute against 85 lb. working pressure. No trouble was experienced in starting up any of the units or during the three-day run. One man was required to watch the operation of the machines. The air power was supplied to foundry equipment, sand blast blowers, and to the testing floor for rock drills, air hoists, and for other compressed-air equipment throughout the plant.

Fig. 3—Battery of seven 220-ft. portable compressors that took care of shop requirements for three days until air mains from power plant were repaired

Dust Explosion Hazard

IN AN address before the Fire Prevention School, Milwaukee Association of Commerce, David Price[1] spoke on the occurrence of dust explosions, their cause and prevention. Although most of his remarks concerned explosion hazards in industrial establishments, some of his suggestions should be noted by superintendents of boiler plants using pulverized fuel.

Most dust explosions take place during the normal operating process, but others have happened under unusual conditions. In some instances explosions have taken place during the fighting of fires in manufacturing plants, resulting in the loss of the lives of firemen engaged in the performance of their duty.

To lessen the dangers to members of the Fire Department and in order that they may become acquainted with the dust hazards, some provisions should be made for periodic investigations or inspections of industrial plants and manufacturing establishments. These inspections serve three important and useful purposes:

1. Conditions which may cause or help spread fires are discovered and remedied.

2. Firemen become thoroughly familiar with the structural conditions of the building and the hazardous process carried on in them.

3. A definite knowledge of the contents of the building and the products handled and manufactured is obtained.

From the investigation of dust explosions that have occurred while fire was in progress, it appears that these explosions might be classified under the following heads:

1. Explosions that occur during the drawing of contents of bins.

2. Explosions that occur during the fighting of fires in plants.

3. Explosions that are due to the force of a full stream of water on piles of dust.

These observations have suggested the following precautionary measures as a possible method of dealing with the various dust explosion causes already referred to:

1. Instead of immediately removing the contents of a bin in which a fire has occurred and is apparently extinguished, it would be better to flood the bin and thoroughly wet the material before undertaking to remove it.

2. Plants should be systematically inspected to acquaint the firemen with any dust explosion hazards. This would make possible the adoption of precautionary measures and not permit the unnecessary exposure of firemen to explosions of this character.

3. It would be preferable to use a spray nozzle instead of the heavy pressure from the hose on explosive dusts which are stored in piles.

In addition to these remarks, one may observe that every effort should be made to eliminate the accumulation of piles of dust in the plants. This work may be greatly helped if in the design of the plant some thought is given to the elimination of places where piles of dust can accumulate.

[1]Engineer in charge, chemical engineering division, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

Future Progress in the Field of Refractories*

THE whole problem of advancement in the utility of refractories is of such a complicated and obscure nature that at times it appears hopeless. The manufacturer or user cannot solve the problem alone, and it is only through the closest co-operation and critical study by each group that significant progress can be made.

One of the two means of accomplishing this aim is by interesting the user in the value resulting from his study of refractory problems. Provided he will become more familiar with the properties and limitations of refractories and apply this knowledge in a critical study of specific conditions in service, the information gained will be of great value to the consumer and producer as well.

The second means of advancement will be through the manufacturer obtaining these service data and developing his material so as to furnish properties that will meet the service conditions to the greatest possible degree.

Maximum life of the refractories under a given set of conditions in service will be obtained only by employing brick that have the specific properties essential for that service. It is logical, therefore, to consider the properties of the brick that are to be purchased. This resolves itself into the use of specifications, which should be an effective means of buying refractories. Experiences with specifications to date, however, have not always been satisfactory, and a little thought will reveal the cause of this condition.

A practical and valuable specification must set forth requirements for the brick that will allow it to render the maximum practical life in the position in which it is to be used. In order to make it practical, however, the requirements must be such that materials can be manufactured so as to meet them and sell at a price satisfactory to both parties. There are definite limitations to the development and combinations of properties that can be made in any refractory product. As a result of these conditions most specifications now in use are of more or less questionable value. As progress is made in the study of service conditions and as more adequate test methods are developed, it will be possible to formulate specifications that will be invaluable.

At the present time it is possible to formulate specifications for most furnace operations that will be of considerable value in spite of their shortcomings. They will offer a means of eliminating in a definite way the types of brick that are unsuitable for the service and leave a group that offer the best possibilities. In order to determine the most suitable brand in this eligible group for the service, it is necessary to conduct service trials, thereby selecting by elimination.

In order to formulate a specification of merit, it is essential that the most experienced technicians of the consuming and producing interests co-operate to supply the information that is vital for its success.

Influence of Specifications

In connection with specifications there should be mentioned the influence that they exert on the trade in general. It will mean that the same language concerning service conditions and operations, properties of refractories and test methods will be used by all. They will set down a definite scientific outline of the refractories problem in each type of service and will supply a clearly defined procedure for the manufacturer to follow. The development of the refractories field to such a scientific and organized basis should be one of the greatest periods in its history of progress.

Another means of increasing the utility of refractories is in the method of their use. Invariably the furnace design and its operation are decided upon without due consideration of the limitations and properties of the available refractories. In the recent meeting of the Fuels Division of the Society, the writer presented a paper showing the relation between conditions of service and properties of refractories. Great advancement can be accomplished in this direction by the consumer assisted by the producer. The correcting of such conditions undoubtedly offers a greater field for progress than does the development of novel refractory materials.

In considering the development of the refractories themselves, the question of demand is basic. As mentioned, the enumeration of specific logical requirements by the consumer will largely influence the rate of progress. At present it is difficult to determine and weigh the importance of certain properties in the various types of service. There is also the question of the sale price of the brick when developed.

Steady progress is being made in all branches of the production in the way of raw materials, methods of forming and in firing. The replacement by machinery of the human element is an important factor in producing more uniform brick. In the firing process the uniformity is being assisted through the application of data obtained in careful studies of kiln firing. The adoption of tunnel kilns is also a noteworthy factor.

*Abstracted from a paper entitled "Future Progress in the Field of Refractories," by Stuart M. Phelps, presented at the meeting of the Iron and Steel Division, A.S.M.E., Youngstown, Ohio, Nov. 10, 1927.

NEWS *of the* FIELD

Standard Gas & Electric Co. Adding 270,000 Kw. to Power Sources

Enlargements of Important Facilities Will Raise Total of Supply by System to More Than 1,340,000 Kw.

CONSTRUCTION by subsidiary affiliated companies of the Standard Gas & Electric Company, now under way or authorized for immediate installation, will add a total of more than 270,000 kw. of electric generating capacity to the resources of these companies, according to the Byllesby Engineering & Management Corporation, in charge of engineering and construction. Upon completion of the work described, the combined generating facilities of companies in the Standard system will total more than 1,340,000 kilowatts.

The Duquesne Light Company, Pittsburgh, has completed the installation of one 40,000-kw. turbine unit of the Colfax station, and a second unit of the same size is reported ready for service.

Louisville Hydro-Electric Company is completing the construction of a hydro-electric plant, with installed capacity of 80,000 kw., at the Falls of the Ohio River, at Louisville.

The first 10,000-kw. unit of the 48,000-kw. Prospect No. 2 development of the California Oregon Power Company, under construction on the north fork of the Rogue River, in Oregon, is nearing completion, and a second unit of the same capacity will be added shortly after the first of the year.

Oklahoma Gas & Electric Company is building an extension to its Harrah steam-electric station near Oklahoma City, and will install an additional turbine unit of 30,000 kw. capacity. Two additional boilers are being installed. Harrah, upon completion of the work now in progress, will have a total capacity of 65,000 kilowatts. This extension is being rushed for early opening.

Development Is Projected For Lower Potomac

The South Branch Power Company, Philadelphia, has made application to amend its preliminary permit, covering proposed developments on the upper Potomac River, to include development on the lower Potomac River, from tidewater in the District of Columbia to Harpers Ferry, W. Va., it has just been announced at the Federal Power Commission.

It was stated by the commission that the proposed amendment would conflict with similar applications for the development of the lower Potomac, made by the Potomac River Corporation, Wilmington, Del., and by Stineman & Quick, Baltimore.

Michigan Engineers Plan Varied Program

The third Michigan Engineering conference will be held at the Hotel Statler, Detroit, beginning on Friday morning Jan. 27 and ending Saturday afternoon, Jan. 28.

The program will include addresses and papers by speakers of national reputation, speaking on subjects as follows:

"Relation of the Engineer to Management," J. L. Harrington, past president, A.S.M.E.; "Electrification of Steam Railroads," W. M. Vandersluis, electrical engineer, Illinois Central R.R.; "Welding," Prof. Comfort A. Adams, Harvard University; "Mississippi River Problem," Arthur E. Morgan, president, Antioch College; "Commercial Aviation," William B. Stout, Stout Metal Airplane Company; "Two Blades Where But One Grew Before," C. F. Hirshfeld, chief of research department, Detroit Edison Company. Dean F. Paul Anderson of the University of Kentucky will speak; the subject has not yet been announced. Other papers are being arranged for.

Engineering Education Body Meets in New York

The Greater New York and Northern New Jersey Section of the Society for the Promotion of Engineering Education held its second annual meeting at New York University, the afternoon and evening of Dec. 3.

Representatives from Princeton, Rutgers, Pratt Institute, Stevens Institute, New York University and Brooklyn Polytechnic Institute inspected the Nichols Chemistry Building which was formally opened. The delegates visited the newly opened Daniel Guggenheim School of Aeronautics which contains the largest wind tunnel in the country. Following the inspection of the building and laboratories dinner will be held at the University Commons. In the evening Harry F. Guggenheim, president of the Daniel Guggenheim Fund for the Promotion of Aeronautics will talk to the engineers and their guests in the Auditorium on "Progress in Aeronautics." Baron Shiba's very high speed motion pictures of aerodynamic flow were shown. These films were given to the University by that Japanese aviation authority.

Charles Manville, Founder of Johns-Manville, Dies

Charles B. Manville, who seventy years ago founded the Manville Covering Company, for the manufacture of insulating material, now developed into the concern of international scope known as the Johns-Manville Corporation, died at his home in Pleasantville, N. Y., Nov. 28, following a short illness resulting from apoplexy. He was 96 years old.

The first product of the new company was designed to ward off the effects of cold, but Mr. Manville was constantly studying other forms of insulation and eventually the name of the firm was perhaps associated in the public mind rather with fireproofing materials, though that is only a part of the many products of the corporation.

From his first combination of woolfelt and clay Mr. Manville advanced to greatly improved devices, notably his magnesia insulating material for pipes.

After the Manville Covering Company had reached large proportions, it moved its headquarters to New York in 1900 and purchased the H. W. Johns Company, a concern operating in much the same field. The companies were brought together under the name of the H. W. Johns-Manville Company, with Mr. Manville as president. This tile was changed in 1920 to Johns-Manville, Inc., and last January the name was again altered to the Johns-Manville Corporation.

Mr. Manville retired from active participation in the business in 1902. He was succeeded as president by the elder of his two sons, Thomas F. Manville, who died two years ago.

Hiram E. Manville was president from 1924 until last June, when he became chairman of the board after purchase of large holdings of common and preferred stock by J. P. Morgan & Co. Theodore F. Merseles, formerly president of Montgomery Ward & Co., is now president of the corporation.

Seventh Annual Report of Federal Power Commission Shows Great Activity

Status of Commission's Work Unimproved—Urges Act to Provide Appropriations Directly for Administration

SINCE the first rush of applications in the year immediately following the passage of the Federal water power act the number of new applications has averaged 100 per annum and has varied but little from this figure in any individual year. The 97 new applications filed during the past fiscal year, 64 of which were for licenses, together with 13 other applications for license by those who had previously held preliminary permits, involve a prospective installation of approximately 3,300,000 horsepower.

Among the most noteworthy in point of capacity of the new applications are the New River project of the Appalachian Electric Power Company with a proposed installation of 100,000 hp., and the Savannah River project of the Savannah River Electric Company of 120,000 hp. Particular interest attaches to certain applications in Alaska because of the plan to develop the water power in extensive pulp and paper mill operations utilizing large blocks of national forest timber. Likewise the application of Potomac River Corporation for a comprehensive development of the Potomac River from its upper tributaries to tidewater has aroused unusual interest, because of its relation to plans for the park development of the National Capital, and to proposals which have been under consideration in Congress for many years for constructing these developments at the expense of the United States.

Thirty-one new projects having an installed capacity when completed of 362,000 hp. have been started during the fiscal year, bringing the total of projects completed or under construction at the close of the year up to 128 with a proposed aggregate installation of 4,610,000 hp. The largest of the new projects for the year are the Carolina Power & Light Company's Pigeon River project in North Carolina, with an ultimate capacity of 105,000 hp., and the Chelan Electric Company's project on Lake Chelan, Wash., with an ultimate capacity of 110,000 horsepower.

Amendment of Act

The situation set forth in the latest annual report with respect to the status of the commission's work has not improved during the year, and in fact can not improve so long as existing conditions continue. The number of new applications for permits and licenses is practically constant from year to year, but that part of the commission's work which is supervisory in character is cumulative, depending upon the entire number of permits and licenses outstanding and not merely upon the applications received or upon the permits and licenses issued in any one year.

The commission repeats its recommendation of last year that the only effective remedy for the unsatisfactory situation which now obtains is legislation which will provide that all costs of the administration of the Federal water power act be carried in appropriations made directly to the commission out of the moneys which are collected to defray such costs—and for no other purpose—such moneys to be segregated in the Treasury for such appropriation as Congress may deem necessary for the adequate administration of the act.

State Water-Power Legislation

The commission in its third annual report called attention to the fact that the control of water-power development on sites over which the Federal Government has jurisdiction is not exclusively a Federal responsibility, but that, if development is to proceed with due consideration of the public interest, the States must likewise assume and exercise responsibilities of their own. The commission has likewise from time to time emphasized the desirability of State and Federal co-operation in such development. At this time it repeats its recommendation of earlier years and particularly points out the desirability of State legislation adapted to co-operation with Federal agencies, providing means for effective control by the States of water-power developments within their borders.

Diesel Proves Able to Supply Power for Construction

That the Diesel engine is eminently suitable to provide the necessary power for the constant and varied needs of plant construction prior to the advent of hydro-electric power, has been amply proved by the Lake St. John Power & Paper Company, which is building a mill at Dolbau, Quebec.

By the historical Mistassini River, where for many years the Indians and trappers paddled up and down to trade with the Hudson's Bay Company, a 200-ton paper mill is in course of construction. When the work started, no power of any kind was available, and building material had to be brought in by boat. Power for construction machinery and lighting was required as soon as operations began, and a 360-hp. Fairbanks-Morse Diesel engine direct connected to a 300-kva. alternator were chosen to provide it. The engine was put into operation about Nov. 1, 1926, and provided power for the machinery during the daytime and for lighting at night. After the first of the year the engine took on a 24-hour load and has been operating continuously since that time. Until the last few weeks the engine carried the entire load without assistance or standby of any kind, and was frequently overloaded. Notwithstanding this fact, it operated perfectly at all times, and allowed the construction work to be carried on without interruption.

Philadelphia Club to Mark Half-Century Birthday

Engineering progress and world civilization, in the past, its present stages and future aspects will be the general topic featuring the fiftieth anniversary exercises of the Engineers Club of Philadelphia, which will be attended by many prominent engineers and their friends at the Bellevue-Stratford, Philadelphia, Dec. 16 and 17.

The program will open Friday evening at 8 o'clock with addresses by John R. Freeman, past-president of the American Society of Civil Engineers, and Ambrose Swasey, past-president American Society of Mechanical Engineers, speaking on "The Past in Engineering Fifty Years Ago—1877." A buffet supper, entertainment and smoker will follow. Saturday morning at 11.30 o'clock a special convocation will be held at College Hall, University of Pennsylvania, for the conferring by the University of three honorary degrees. A buffet luncheon is called for at noon.

"The Present in Engineering—1927" will be the meat of a short symposium in the afternoon by Charles M. Schwab, William C. L. Eglin, president of the Franklin Institute, and Howard Elliott, chairman of the board of the Northern Pacific Railway, which will be supplemented at the closing session in the evening by talks on "The Future in Engineering—1977," by Samuel Rea, past-president of Pennsylvania Railroad, Dexter S. Kimball and John Hays Hammond.

Non-members desiring to attend any of these functions will please communicate before Dec. 12 with the Secretary, The Engineers Club of Philadelphia, 1317 Spruce St., Philadelphia.

Alabama Power Takes Over Control of Two Concerns

The Alabama Power Company has taken over control of the Gulf Electric Company and the Houston Power Company, according to recent announcement.

The Gulf Electric Company operates plants at Mobile and Pensacola, Fla., and 20 others in Southwest Alabama and West Florida. The Houston Power Company supplies electric power to Dothan and several other Southeast Alabama towns.

Boston Engineers to Review Welding Problems

An exhaustive symposium on modern welding will feature an all-day and evening program Dec. 14 under the auspices of the Affiliated Technical Societies of Boston.

Sessions will open at 10 a.m. at Chipman Hall, 88 Tremont Street, Frank B. Walker, chief engineer Eastern Massachusetts Street Railway Company, presiding, with the following papers: "General Principles of the Various Welding Processes," F. M. Farmer, president American Welding Society, New York; "Examples of Arc-Welded Steel Construction," Gilbert D. Fish, consulting engineer, Westinghouse Electric & Manufacturing Company, New York; and "Welding Trusses for Industrial Building," Andrew Vogel, General Electric Company, Schenectady, N. Y.

Papers to Follow Luncheon

At 1 p.m. a luncheon will be held at the Boston City Club under the auspices of the New England Water Works Association, and at 2 o'clock the afternoon session will start in the City Club auditorium, under the chairmanship of George A. Carpenter, president of the Association. The following papers will be given: "Pipe Line Welding from the Oxy-Acetylene Viewpoint," LeRoy Edwards, Air Reduction Sales Company, New York; "Pipe Welding and Other Recent Developments," D. H. Deyoe, General Electric Company, Schenectady; "Thermit Pipe Welding," Robert L. Browne, New York and New England district sales manager, Metal & Thermit Corporation, Boston, Mass.; "Replacing Castings by Steel Elements," Dr. A. Krebs, General Welding & Equipment Company, Boston; and "The Metallurgy of Welding-Wire," C. A. McCune, director of research, American Chain Company, Bridgeport, Conn.

Warns of Fraudulent Sales Letters and Methods

Letters of introduction from foreign banks to well known banks in America are being used to gain confidence of officials of large industrial establishments in this country. After such letters have been presented some companies have found themselves liable for many thousands of dollars.

Recently a salesman of a foreign concern showed the president of a Cleveland factory a letter from the Bank of France to the Mellon National Bank of Pittsburgh, explaining that he was then en route to present his letter in person. That president placed a small trial order for tool steel said to be of unusually high quality. He learned later that his trial order was billed at over eight hundred dollars and the material was of mediocre quality. Instead of ordering a sample lot for trial, investigation showed he had signed an order which could be interpreted to cover enough tool steel of the sizes specified to last his plant indefinitely.

Until the methods used in securing "trial orders" are analyzed, it would seem unbelievable that such practices could succeed. Close watch and unquestionable identification should be adhered to in all such cases.

Tokyo Electric Light Plant Unit for Steam Standby

For the new extension of the Senju power plant, near Tokyo, Japan, the Tokyo Electric Light Company has completed plans of a 25,000-kw. turbine-generator.

The Senju power plant is a steam stand-by station, just outside the City of Tokyo. This unit will be of the same design as two machines installed there in 1925, and will bring the capacity of the station up to a total of 75,000 kw. It will be built at the South Philadelphia Works of the Westinghouse Electric & Manufacturing Company.

The Tokyo Electric Light Company is the largest power company in Japan, and draws most of its power from hydro-electric installations, the stand-by station at Senju having in the past been idle for as many as eleven months out of the year. To make the station serviceable the year 'round, special arrangements will be made so that the generators can be used for power factor correction during the season when there is an abundance of water power.

This will be the first time that a steam stand-by station has been so used in Japan.

In order to make the three 25,000-kw. generators available as synchronous condensers, special disconnecting couplings will be supplied between the turbines and the generators. These couplings will be arranged to permit connecting or disconnecting the generators while the units are at a standstill.

Since the boilers are shut down during the season when the units are not needed for the generation of power, it is necessary to provide means for starting the generators electrically. It was finally determined to do this by means of a motor-generator set of sufficient capacity to start one generator at a time electrically. When used in this manner, the 25,000-kw. generators will have a capacity of 20,000 kva. 0 per cent P.F. leading. In order to facilitate starting of the generator, when used as a synchronous condenser, a special high-pressure oiling device will be provided, by means of which lubrication can be established before the generator rotor is rolled over.

Pinchot To Support Power Inquiry Resolution

Following the announcement of Senator Thomas J. Walsh, of Montana, that he will reintroduce at the coming session of Congress his resolution for an investigation of concentration in the control of electric power, Gifford Pinchot, former Governor of Pennsylvania has stated his willingness, in the event of its passage, "to submit facts which I believe furnish definite proof of the existence, ownership, and extent of this concentration, together with material on methods of financing stock inflation, and the exploitation of the electric monopoly."

Films Show Value of Industrial Museum

IN ORDER to show American audiences what can be accomplished by industrial museums, the trustees of the Museum of the Peaceful Arts in the City of New York have had made for them three motion picture films of the four great industrial museums of Europe. These were shown for the first time to a group of New York business men and industrialists Nov. 29.

The reels were made under the personal direction of Charles T. Gwynne, vice-president of the Chamber of Commerce of the State of New York and one of the trustees of the Museum. The museums whose buildings and exhibits were filmed are the Science Museum, London; the Conservatoire des Arts et Metiers, Paris; the Deutsches Museum, Munich; and the Technisches Museum, Vienna.

The principal film, entitled "Museums of the New Age," shows how the interest of the public, as well as of technical men and students, can be aroused in a display of progress of the useful arts. Point is made, through the captions, that such a museum fits well into the scheme of modern education, because science and industry play such an important part in present day life. That thought is also implied in the caption of the film, "Museums of the New Age." It is proposed to erect a large industrial museum in New York, and it is the expectation of the trustees that they will have available a bequest from the will of Henry R. Towne to the extent of about $2,500,000. The City of New York has virtually agreed to donate a site for the museum at the old Jerome Park reservoir area.

Dr. George F. Kunz is president, and among the other trustees are: Calvin W. Rice, Frederick A. Goetze, John W. Lieb, L. F. Loree, Elmer A. Sperry, Michael I. Pupin, Thomas A. Edison, Samuel W. Stratton, Ambrose Swasey, Frank A. Vanderlip and Nicholas Murray Butler.

Sees Central Heat Chief Aid in War on Smoke

Seeing central plants as the only means of realizing a nearly smokeless city through the elimination of "many belching smokestacks," Doctor Harris, Health Commissioner of New York, expressed confidence, Nov. 24, that this plan will be tried successfully in connection with the heating of the east side apartment houses to be built under the new housing law. The Smoke Abatement Advisory Committee has endorsed the plan and has recently taken it up as a possible remedy. If this is successful Doctor Harris said, "an impressive demonstration could be made of the lessening of smoke by furnaces carefully designed for that purpose, as well as a demonstration of the freedom from smoke that could be enjoyed by the district supplied with heat from a central source.

To License Heating Plants

"New York City," Doctor Harris said "is suffering from growing pains. Many changes have been and are being made. One of our greatest smoke problems, for instance, lies in the use of oil as fuel for furnaces. This use of oil has been and still is growing by leaps and bounds. Such furnaces are quite effective, but, for a while, at least, they produce great quantities of heavy black smoke.

"We have given some consideration to the proposal of Prof. Charles E. Lucke, head of the department of mechanical engineering at Columbia University and a member of the Smoke Abatement Advisory Committee. This plan suggests licensing every heating plant and industrial establishment in the city as a means of covering the cost of making New York smokeless."

In connection with the central plan Doctor Harris said that the New York Steam Company was now using such a plant which was serving hospitals, homes and other buildings with success, with a lessening of the smoke nuisance, inasmuch as it substituted one smoking chimney for many, and the methods employed in such a heating plant were adopted with a view to abating the quantity of black smoke emitted.

Czechoslovakia Revises Her Boiler Regulations

Existing boiler regulations in Czechoslovakia are to be revised, according to a report from Commercial Attaché Elbert Baldwin, Prague to the Department of Commerce. The Ministry of Labor has already prepared the draft of a new bill but this draft is said to have encountered opposition.

A series of conferences will now be held with representatives of industrial and electro-technical associations as well as of the Foremen and Engineers' Union. The first conference was held in Prague on Nov. 7, and new legislation will be prepared after the matter has been thoroughly discussed with these organizations.

William B. Rufe, Secretary of Jenkins Bros., Dies

William Byron Rufe, secretary of Jenkins Bros., New York, and also secretary of Jenkins Bros., Ltd., the Canadian branch of this concern, died in Brooklyn, N. Y., Nov. 27.

Mr. Rufe was born in Lehigh County, Pa., 56 years ago. His uncle was one

William B. Rufe

of the first shorthand writers, and young Rufe learned shorthand from him by mail.

At the age of fifteen he came to New York and obtained employment in a lawyer's office. This type of employment did not interest him, as he decided there was not enough work to keep him busy, so he answered an advertisement signed "J. B." and was employed by Jenkins Bros. as their first stenographer. He became secretary of this firm on its incorporation in 1907 and in January, 1928, would have completed 40 years of service.

A man of great activity and sterling integrity, Mr. Rufe will be mourned by a large circle of friends in the valve and supply trade.

N.E.L.A. Moves Home

After Dec. 19 the address of the headquarters office of the National Electric Light Association will be 420 Lexington Avenue, New York City, instead of 29 West 39th Street. The change in location will be made in order to house, on one floor and under one roof, all headquarters departments and activities, in the interest of economic adiminstration.

Tests Show Welded Joints Strong as Riveted

That welded joints in structural members may be produced having holding values equivalent to those of riveted joints is indicated by demonstration in a series of tests recently conducted by the General Electric Company.

Test specimens were made using the metallic arc welding process, and the actual testing of specimens was conducted under the direction of Prof. T. R. Lawson of the Rensselaer Polytechnic Institute, in the laboratory of that institution.

The tests were made on $\frac{1}{4}$-, $\frac{5}{16}$- and $\frac{3}{8}$-in. fillet welds, this type of weld being commonly used in fabricating machine parts and steel structures from standard rolled steel shapes. On each size of fillet there were made tension and compression tests, fillet lengths being $\frac{1}{2}$, 1, 2, 3, 4, 5 and 6 inches.

Lowest Average Represented

A summary of the results of the tests shows that a $\frac{1}{4}$-in. fillet will stand a safe allowable load of 2,600 lb. per lineal inch, using four as a factor of safety. Corresponding values for $\frac{5}{16}$- and $\frac{3}{8}$-in. fillets are 2,900 and 3,200 lb. According to William Dalton, of the General Electric Company, a $\frac{3}{4}$-in. rivet will stand a shearing load of 4,500 lb. per lineal inch. Based on the results of the recent tests, a $\frac{3}{8}$-in. fillet will sustain approximately the same load if deposited for a length of $1\frac{1}{2}$ inches.

In summarizing the results of the fillet weld tests, care was taken to use values representing the lowest average of test results on a number of fillets of the same size and length. This is important in view of the fact that, in many machine parts, members may be subjected alternately to tension and compression, and to vibratory stresses. The welds tested were all made by hand and were made in one layer; that is, the entire fillet was built up in a single pass along the joint.

Consumers' Public Service Co. Seeks to Buy Three

The Consumers' Public Service Co., with headquarters at Brookfield, Linn County, recently filed application with the State Public Service Commission to purchase electric utilities operating in four north central Missouri counties.

The company, recently incorporated, asks authority to buy the Browning Purdin Electric Company, the Laclede Electric Light Company and the Rothville-Summer Electric Company. The companies operate plants at Browning, Purdin, Humphreys, Osgood, Harris, Newton, Laclede, Rothville, and Summer in Linn, Chariton, Sullivan and Putnam counties.

Canadian Water Power Nears 5,000,000-Hp. Mark

By the end of the present year the total installation of water-power plants in Canada will be 4,883,000 hp., and, if the present rate of increase continues, will easily have passed the 5,000,000 mark by the end of 1928, according to statistics compiled and issued by J. T. Johnston, director of the Water Power Branch, Department of the Interior.

Indicating the rapid growth of hydro-electric development in the Dominion, it is pointed out that in 1900 the total installation amounted to only 170,000 hp. During the subsequent decade that development grew to 975,00 hp.; at the close of 1914 it was 1,946,000 hp., and at the end of 1920 it had increased to 2,508,000 horsepower.

As further evidence of Canada's possible installation, Mr. Johnston indicates: "It is not correct to subtract the total installation at November 1 (4,883,00 hp.) from the totals of available power to determine what power remains undeveloped, as investigation has shown that throughout the Dominion the installations at developed sites exceed the estimates of ordinary six-month power at such sites by about 30 per cent. On this basis the total recorded resources of Canada would warrant the installation of about 43,000,000 hp. In other words, the present turbine installation represents slightly more than 11 per cent of the total resources."

The total capital invested in the water power industry in Canada at this date is estimated to be $900,000,000, or more than that for any other single manufacturing industry. The corresponding figure in 1910 was $121,600,000, so that the increase in seventeen years is over 600 per cent.

Insull Buys New Utility

The Samuel Insull interests have bought control of the Western United Gas & Electric Company, a $32,000,000 public utility in the Fox River Valley centering in Aurora and Elgin, Ill. This adds another unit to an estimated total capitalization of more than $750,000,000.

New 360,000 Kw. Generating Station for London

The British Electricity Commissioners have finally approved the plan for the erection by the London Power Company, Ltd., of a new generating station at Battersea, a southern suburb. Preliminary designs which were submitted to the Commission are being subjected to careful revision, and it is thought that early in the coming year the construction of the station will be begun.

The company will take the best-known precautions for the consumption of smoke and for preventing as far as practicable the evolution of oxides of sulphur.

The erection of this new station with every modern improvement will enable it to shut down older and less efficient stations. Its site is conveniently located for the co-ordination of the generation and transmission of electrical energy, which it is the purpose of the company to secure. When the reorganization now in progress is completed current will be generated at six stations for London, placed at Battersea, Deptford (East and West), Bow, Grove Road, and Willesden. The Willesden station is being modernized and extended, and, subject to the necessary contents being received, will have a capacity of 100,000 kw. Further extensions at Grove Road are only possible to a very limited extent, while the Bow station is practically completed.

The new station, to be known as Deptford West, is being built alongside the existing Deptford East station at a cost for the first stage of $7,500,000. The Battersea station, which will be the largest of the six, is to cost, including its transmission system, $25,000,000 and will eventually have a capacity of 360,000 kilowatt.

To Talk on Thermal Engineering in Soviet Russia

Prof. Leonide Ramzine, director of the Thermotechnique Institute of Moscow, will speak before the Russian Association of Engineers on "Achievements of Thermal Engineering in the United States of Soviet Russia and the United States of America," at the Hotel Pennsylvania, New York City, at 8:15, Dec. 9.

Professor Ramzine has just completed an extensive tour of the United States.

Boulder Dam Bill Awakens

The Swing-Johnson bill which would provide for construction of Boulder Canyon Dam, will be reintroduced as soon as Congress convenes, Senator Johnson (Rep.), of California, co-author of the bill, announced orally November 29. Senator Johnson expressed confidence that the bill will be enacted into law.

Stoker Production Continues Upward Trend

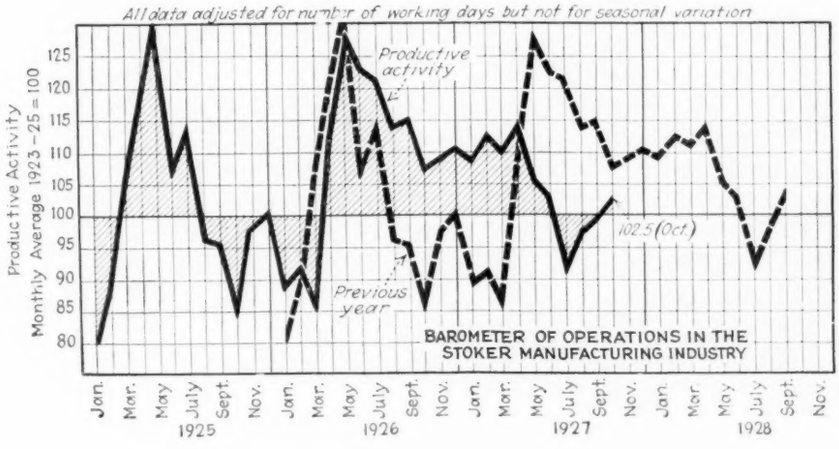
IT APPEARS that the upward trend in stoker production which started in August was continued through September.

The activity in the stoker manufacturing plants as indicated by the consumption of electrical energy during October was 2.8 per cent over September and 5 per cent over August, but was 7.9 per cent under October last year. The stoker manufacturing plants appear to have been operating at a rate under that reported for the same month last year ever since April.

The summer months of 1926 witnessed a high rate of activity which was not duplicated during the current year. On the other hand, the current year has not witnessed the low rate of productive activity reported at the opening of 1926. Aggregate stoker production during the first nine months of the current year has been about 4 per cent under that of the same period 1926, but 1.5 per cent over the first nine months of 1925.

The index of activity in the stoker manufacturing industry based upon electrical energy consumption stands at 102.5 for October as compared with 99.8 for September. Comparative indexes of productive activity referred to the average activity for the year 1925 as 100, and adjusted for number of working days is as follows:

October, 1927	102.5
September, 1927	99.8
August, 1927	97.7
October, 1926	111.4
October, 1925	87.9
Average last six months 1927	109.1
Average for full year 1926	108.8



To Install Six Vertical Single Pass Condensers

The Commonwealth Edison Company, Chicago, will install six vertical single pass condensers to be used for condensing steam from the 100,000 kw. steam turbine generator unit at the Crawford Avenue station.

Each condenser is 29 ft. high and has a diameter of 11 ft. When filled with circulating water the six condensers will weigh 558 tons. The condensers and the turbine were built at the South Philadelphia Works of the Westinghouse Electric & Manufacturing Company.

Work on Chippewa Falls Hydro Plant Under Way

Northern States Power Company has launched work in earnest on the development of hydro-electric power at Chippewa Falls, Wis., on the Chippewa River, as the above illustration.

The Chippewa Falls plant will have a capacity of 30,000 hp., in six units of 5,000 hp. each. The dam and power house will be located in Chippewa Falls, about three miles below the hydro-electric development at Wissota, which has a capacity of 42,000 horsepower.

Flood Damage Heavy for New Hampshire Plants

Damage from the flood to hydro-electric stations and dams, near Walpole, N. H., across the Connecticut River from Bellows Falls, will run from $1,500,000 to $3,000,000, according to John Storrs, chairman of the New Hampshire Public Service Commission, who has made a survey at that point and state under Nov. 18. It will be difficult to divide loss between Bellows Falls and Walpole, he said. This is due to the fact that the river has created two new channels.

Diesel Replaces Wood Burning

Decision to replace the present wood-burning equipment of the electric light plant with a Diesel engine and generator, at a probable cost of $60,000 was reached at a recent meeting of the city council of Dauphin, Manitoba.

Society Affairs

A.S.M.E. and WESTERN SOCIETY OF ENGINEERS will hold a joint meeting Dec. 19, 1936 Monadnock Block, Chicago,—subject, "Energy from the Atom."

A.S.M.E., BUFFALO, Dec. 13, Hotel Statler, at 8:00 p.m.; "The Present Standing of Various Standards Now Being Developed for Valves and Fittings for High Pressure Steam Service," by F. H. Morhead, chief engineer of the Walworth Company. There will also be slides showing in detail the design of high pressure valves and fittings for application to service requirements.

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Engineering Council, annual meeting will be held in Washington, D. C., Jan. 9-11; L. W. Wallace, executive secretary, 26 Jackson Place, N. W., Washington, D. C.

American Society of Heating & Ventilating Engineers, hold general meeting at Hotel Pennsylvania in New York City, Jan. 23-26; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Refrigerating Engineers, annual convention in New York, Dec. 5-7; W. H. Ross, sec., 37 W. 39th St., New York City.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

American Society of Mechanical Engineers, convention during week of New York Power Show, New York City, Dec. 5-10; Calvin Rice, sec., 29 West 39th St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 14-17; G. E. Pfisterer, sec., 53 West Jackson Blvd., Chicago.

National District Heating Association, annual meeting in May; D. L. Gaskill, sec. 112 West 4th St., Greenville, Ohio.

New York Power Show (National Exposition of Power and Mechanical Engineering) will be held at the Grand Central Palace, New York City, Dec. 5-10. Address inquiries to the International Exposition Co., Grand Central Palace.

The National Marine Engineers' Beneficial Association, 53rd annual convention, will meet at the Lee House, 15th and L Streets, N. W., Washington, D. C., February 13-18. Albert L. Jones, Secretary-Treasurer, 313 Machinists Building, Washington, D. C.

Power Transmission Association. Annual meeting, Hotel Commodore, New York City, Dec. 7; W. S. Hays, Sec., Drexel Building, Philadelphia.

AMERICAN REFRACTORIES INSTITUTE will hold meetings at the Hotel Chase, St. Louis, Mo., Dec. 6-7. Papers of interest will include "Dry Grinding of Refractories," by Mr. J. M. Gallaher, works manager, Clearfield Machine Company, Clearfield, Pa., and "Burning Refractories with Stokers," by Massillon Refractories Company, Massillon, Ohio. Inquiries concerning sessions should be directed to the secretary of the American Refractories Institute, 2202 Oliver Building, Pittsburgh.

AMERICAN INSTITUTE of Weights and Measures, 115 Broadway, New York City, will hold its annual meeting at 2.30, Dec. 8. Following administration business plans will be discussed for the

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Nov. 22 1927
Pool 1	New York	$2.35@$2.75
Smokeless	Boston	1.39
Clearfield	Boston	1.60@ 1.85
Somerset	Boston	1.70@ 2.00
Kanawha	Columbus	1.40@ 1.60
Hocking	Columbus	1.50@ 1.75
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.10@ 1.25
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.00@ 2.35
West Ky.	Louisville	1.00@ 1.50
S. E. Ky.	Louisville	1.25@ 1.75
Big Seam	Birmingham	1.65@ 2.00
Anthracite (Gross Tons)		
Buckwheat No. 1.	New York	2.75@ 3.25
Buckwheat No. 1.	Philadelphia	3.00@ 3.75
Birdseye	New York	1.40@ 1.65

FUEL OIL

New York—Dec. 1, light oil, tank-car lots, 26 deg. Baumé, 5c. per gal.; 28 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Nov. 22, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.28c. per gal.; 38@40 deg., 5¼c. per gal.

Pittsburgh—Nov. 28, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4¾c. per gal.

Philadelphia—Nov. 24, 26@30 deg., $1.60@$1.66 per bbl.; 13@19 deg., $1.56 @$1.62 per bbl.; 22 plus, $1.79@$1.85 per bbl.; 27@30, $2.10@$2.16 per bbl.

Cincinnati—Nov. 29, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Nov. 22, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05 per bbl.

Boston—Nov. 28, tank-car lots, f.o.b., 12@14 deg. Baumé, 4.22c. per gal.; 28@ 32 deg., 5¾c. per gal.

Dallas—Nov. 26, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

recommendation of names for the thousandth of an inch, a small American unit of volume of the order of magnitude of the cubic centimeter, and a unit of weight to replace the gram.

Obituary

DAVID N. ARMSTRONG, president of the Armstrong Manufacturing Company, Bridgeport, Conn., died Nov. 11.

Business Notes

The W. B. CONNOR COMPANY, INC., New York City, which makes and distributes Ace steam traps (non-return type), Ace air filters and Dubus pumps for viscous liquids, has acquired from the Stebbins Engineering & Manufacturing Company all rights, patents and interests in the Shortt pumping trap. The company is now prepared to furnish this trap in a variety of capacities for pumping high-temperature fluids such as oil, condensates, gasoline, acids, etc., and for draining condensers, dry kilns, blast coils, vacuum pans, water heaters, receivers, paper drying machines and similar equipment, and for feeding boilers. Requests for information relative to the Shortt trap should be addressed to the W. B. Connor Company, Inc., 369 Lexington Ave., New York City.

The SWARTWOUT COMPANY, of Cleveland, has opened a Southern office at Atlanta, to provide direct service for buyers of power-plant specialties, ventilation equipment and various types of ovens. This office is at 759 Peachtree St., and is in the charge of P. H. Nichols.

Trade Catalogs

FRICTION CLUTCHES AND TRANSMISSION MACHINERY—Foote Bros. Gear & Machine Company has in the course of preparation, a new catalog covering friction clutches and transmission machinery and equipment, as manufactured by the A. Plamondon Manufacturing Company, whose plant and business it recently purchased. This will be known as Catalog No. 68 and will soon be available for distribution. It is suggested that those interested write for a copy.

COVERING POWER OF PROTECTIVE COATINGS—The Dampney Company of America, Hyde Park, Boston, in a recent Bulletin No. 1136 describes the various types of power plant equipment to which the company's protective coatings are applied, and gives data as to covering power, suitable shipping containers, temperatures, etc.

INSULATION—The Philip Carey Company, Cincinnati, describes in bulletin 101A, Hi-Temp No. 12, an insulation for temperatures between 500 and 1,200 deg. F. Besides giving data on heat transfer rates and insulation efficiency, it also shows the results of transverse loading tests and impact resistance tests before and after the material has been heated in electric ovens for 24 hours at various temperatures. Data are also given on a large sheet type of insulation called Carey Thermalite and is for use between 600 and 1,200 deg. F.

NEW PLANT CONSTRUCTION

Calif., Escondido — Escondido Mutual Water Co. plans an election to vote $45,000 bonds for the construction of a 50 in. penstock from Lake Wahlford and installation of electrical equipment.

Calif., Los Angeles—J. & D. B. Parkinson, Title Insurance Bldg., Archts., are receiving bids for a 13 story medical building on Wilshire Blvd. for Los Angeles County Medical Bldg., Corp., W. Morrison, Pres., Pacific Mutual Bldg.

Calif., San Francisco—M. & L. Graf, 1179 Market St., is having plans prepared for an 18 story theatre and hotel including gymnasium, swimming pool, etc., at Turk and Jones Sts. Estimated cost $5,000,000. H. W. Abrahams, 495 14th Ave., is engineer.

Ill., Chicago—W. C. Bannerman & Co., 77 West Washington St., are receiving bids for a 24 story apartment building at 1430 Lake Shore Drive. Estimated cost $2,000,000. R. S. DeGoyler & Co., 307 North Michigan Ave., are architects.

Ill., Chicago—Marshall Field Estate, c/o A. J. Thomas, 2 West 46th St., New York, N. Y., Archt., is having preliminary plans prepared for a 5 story apartment building on two square blocks, area bounded by Conners St., Hudson Ave. Sedgwick and Blackhaws Sts. here. Estimated cost $4,000,000.

Ind., Fort Wayne—Hilgeman & Schaaf, 209 East Wayne St., is having preliminary plans prepared for an 8 story hotel including steam heating system, elevators, etc. at Fairfield and Berry Sts. Estimated cost $1,000,000. A. M. Strauss, 415 Cal-Wayne Bldg., is architect. Holden Hotels Co., Chicago, Ill., lessee.

Ia., Webster City—City is having plans prepared for the construction of a 100 ft. dam on Boone River including reservoir, power plant equipment, etc. Estimated cost $50,000. G. J. Long is engineer.

Kan., Manhattan — Kansas State Agricultural College, will receive bids about Dec. 15, for the construction of a power and heating plant. Estimated cost $315,000.

Mass., Boston—Hospital Dept. had revised plans prepared for the construction of a boiler house at City Hospital, Albany St. Estimated cost $200,000. J. H. Ritchie & Associates, 250 Stuart St., are architects. R. D. Kimball & Co., 6 Beacon St., are engineers. Former reported contract rescinded.

Mass., Boston—Penal Institutions Dept., P. A. Chapman, City Hall, Comr., will receive bids until Dec. 15 for the construction of a power house at Deer Island, Boston Harbor. Estimated cost $50,000. J. H. Ritch'e & Associates, 250 Stuart St., are architects.

Mass., Lawrence—B. L. McDonald, 398 Essex St., awarded contract for an artificial ice plant on Andover St. to L. C. Cyr, 45 Melrose St. Estimated cost $40,000.

Mass., West Springfield (Springfield P. O.)—Boston & Albany R.R., South Station, Boston, awarded contract for the construction of a power plant here, to J. G. Roy & Sons Co., 21 Silver St., Springfield.

Mich., Detroit—Hudson Motor Car Co., 12601 East Jefferson Ave., is having plans prepared for the construction of a storage building for auto bodies, including detached power plant. Estimated cost $125,000. A. Kahn, 1000 Marquette Bldg., is architect.

Mo., Kansas City—Southwestern Bell Telephone Co., Telephone Bldg., St. Louis, awarded contract for steel for a 13 story addition to office building including ventilation system, boilers, elevators, etc. at 11th and Oak Sts. here.

Neb., Harvard—City plans an election about Dec. 15 to vote $50,000 bonds for the construction of a Diesel engine electric light plant and distribution system. Grant, Fulton & Letton, 525 South 13th St., Lincoln, are engineers.

N. J., Camden—First Camden National Bank & Trust Co., W. E. Bennett, chn. Building Committee, Second and Market Sts. will receive bids until Dec. 9 for a bank and office building including boilers, elevators, etc. at Broadway and Cooper St. Simon & Simon, 249 Juniper St., Philadelphia, are architects.

N. J., Keansburg—H. J. Fowler, 235 Creek Rd., will build addition to ice storage plant. Estimated cost $40,000. Private plans. Work will be done by separate contracts.

N. J., Newark—Owner, c/o F. Grad, 1023 Broad St., Archt., is having sketches made for a 20 story hotel including steam heating system, boilers, elevators, etc., at Broad and Camp Sts. Estimated cost $1,000,000.

N. J., Newton — Bd. of Freeholders, County Court House, is having plans prepared for the construction of a hospital. Estimated cost $500,000. Sutton & Calkins, 402 Broad St., Newark, are architects.

N. Y., Brooklyn—Corporation, c/o Drapkin & Goldberg Construction Co., 44 Court St., Contrs., awarded contract for a 6 story apartment building at Ocean Parkway and Sherman St. Estimated cost $1,000,000. W. T. McCarthy, 159 Remsen St., is architect.

N. Y., New York—A. D'Antona, 100 West 72nd St., will build a 15 story apartment at East 96th St. between 5th and Madison Aves. Estimated cost $1,000,000. R. Candela, 578 Madison Ave., is architect. Work will be done by separate contracts. Owner is general contractor.

N. Y., New York—V. Green Construction Co., 45 West 34th St., will build a 12 story terminal building at Hudson, Canal and Desbrosses Sts. Estimated cost $800,000. Renwick, Aspinwall & Goad, 8 West 40th St., are architects. Work will be done by separate contracts.

N. Y., New York — Havermeryer Construction Co. will build a 24 story hotel and theatre building at Broadway and 5th St. Estimated cost $5,000,000. W. W. Ahlschlager, 65 East Huron St., Chicago, Ill., is architect. Work will be done by separate contracts.

N. Y., New York—Barnett M. & Nathan C. House, 17 West 96th St., are receiving bids for a 15 story apartment building at 229 East 79th St. Estimated cost $900,000. Ellis, Aaronson & Heidrich, 25 West 43rd St., are architects. Estimated cost $900,000 Work will be done by separate contracts. Owners are general contractors.

N. Y., New York—New York Edison Co., 15th St. and Irving Pl., is having plans prepared for construction work, etc. as follows: addition to power plant at East River and 14th St. to house two units, one unit single shaft, 160,000 kw. General Electric generator, cost including equipment $4,000,000; tie station at Water Side Plant ft. 40th St., two 40,000 kw. frequency chambers, transformers and circuit breakers to tie stations together, cost $3,000,000. T. E. Murray, 55 Duane St., is engineer. also takes bids about Dec. 8 for addition to sub-station on 6th St., bids in January for addition to sub-station at Tibbets Ave. and 238th St., distributing station, a.c. type, and bids in March for sub-station at Dey and Washington Sts., cost to exceed $550,000. W. Whitehill, 709 6th Ave., is engineer.

N. Y., New York—New York Edison Co., 15th St. and Irving Pl., awarded contract for an addition to distributing and substation on West 36th St. to Kenn-Well Construction Co., 45 East 17th St. Estimated cost $300,000.

N. Y., New York—One Thousand Park Ave. Inc., c/o Schwartz & Gross, 347 5th Ave., Archts., will build a 14 story apartment at Park Ave. and 88th St. Estimated cost $1,800,000. Work will be done by separate contracts.

N. Y., New York—Salvation Army, 122 West 14th St., is having preliminary sketches made for the construction of an assembly building and hotel at 126 West 14th St. Estimated cost $2,000,000. Architect and engineer not selected.

N. Y., New York—Two Thousand Eight Hundred University Ave. Corp., 1841 Broadway, is receiving bids for the construction of three five story apartment buildings at Holland and Burke Aves. Estimated total cost $525,000. S. J. Kessler, 529 Courtland Ave., is architect.

O., Columbus—Bd. Trustees, Ohio State University, C. E. Steeb, Secy., plans addition to power house. Estimated cost $160,000. W. C. McCracken, is engineer.

O., Columbus—Dept. of Welfare, J. E. Harper, Dir., is having plans prepared for the construction of various institutions including power house and equipment and cold storage plant, etc., at Hawthornden Farm, Cleveland State Hospital, $180,000, power house and equipment at Institution for Feeble Minded, $175,000, etc. Estimated total cost $1,175,000. H. B. Briggs is architect.

Tenn., Nashville—Agricultural & Industrial State Normal School, P. L. Harned, Comr. of Education, will soon award contract for the construction of a power and heating plant on Campus. Estimated cost $150,000.

Texas—Prairie Oil & Gas Co., Independence, Kan., is receiving bids for the construction of three booster pumping stations, 5,000 hp. capacity each at points on the main pipe line from Amarillo, Tex. to Denver, Colo. Estimated cost $450,000. Ford, Bacon & Davis, 428 Colorado Springs National Bank Bldg., Colorado Springs, Colo., are engineers.

Tex., Amarillo—Phillips Petroleum Co. will build a waterworks system including pumping units, etc., in Gray County by day labor to supply fields and the new casinghead gasoline plant to be constructed there. Estimated cost $125,000. Private plans.

Tex., Big Spring—Southern Ice & Utilities Co., c/o E. A. Kelley, Mgr., will build a 30 ton ice plant by day labor. Estimated cost $35,000. Private plans.

Tex., Carrizo Springs—City voted $50,000 bonds for waterworks improvements including well, pumping unit, etc. E. L. Jeffrey, mayor.

Tex., Dickinson—Dickinson Ice & Fuel Co. plans the construction of a waterworks system probably including pumping unit, 50,000 gal. tank on tower, etc. Estimated cost $15,000. Work will probably be done by day labor.

Tex., Edcouch—Valley Electric & Ice Co., Brownsville, subsidiary of Central Power & Light Co., Frost Bldg., San Antonio, will build a 25 ton ice plant here, by day labor. Estimated cost $32,000.

Tex., Fairfield—C. W. Mitchell & Associates, c/o Chamber of Commerce, is having plans prepared for the construction of a 30 ton ice and cold storage plant. Estimated cost $60,000.

Tex., Fort Worth—W. C. Hedrick, Archt., will soon receive bids for an 18 story theatre and office building at West 7th and Lamar Sts. for Fort Worth Properties Co., c/o J. H. Jones, Houston. Estimated cost $1,000,000.

Tex., Fort Worth—Montgomery Ward & Co., R. D. Halbower, Mgr., 2601 West 7th St., will soon receive bids for the construction of an 8 story plant and office building at Camp Bowie Blvd. Estimated cost $2,000,000. Architect and engineer not selected.

Tex., Robstown—Central Power & Light Co., Frost Bldg., San Antonio, is having plans prepared for the construction of an ice docking plant here. Estimated cost $45,000. Private plans. Electrically driven hoisting machinery will be required.

Tex., San Benito—Central Power & Light Co., Frost Bldg., San Antonio, will build a filtration pumping plant, 1,000,000 gal. daily capacity, by day labor. Estimated cost $250,000. Work will be done under the supervision of J. W. Wolter.

Manitoba—Flin Flon Mining Co., Mining Corporation of Canada, Winnipeg, plans a smelter capable of treating 3,000 ton of ore per day, also water power development 270,000 hp. ultimate capacity.

Ont., Toronto—D. E. Bennett, Temple Bldg., plans a 15 to 20 story office and garage building, including steam heating system, elevators, etc. at York and King Sts. Estimated cost $2,000,000. Architect and engineer not selected.

Ont., Toronto—Henry Falk, 23 Woodside Ave., is having plans prepared for a 6 story apartment building including steam heating system, elevators, etc. on Avenue Rd. Estimated cost $1,000,000. Baldwin & Green, 31 Bloor St. E., are architects.

Ont., Toronto—Toronto Transportation Comn., 35 Yonge St., plans the construction of new car barns and yards including boiler plant, etc. in the Runnymede Dist. Estimated cost $500,000. Private plans.

Equipment Wanted

Air Compressors—St. Lucie Motors Inc., Stuart, Fla., are in the market for air compressors.

Boiler — F. F. Treleaven, Mayor, City Hall, Hamilton, Ont., will receive bids until Dec. 7 for one 450 hp. hand fired horizontal tube steam boiler, etc., in connection with Beach Waterworks pumping station. Estimated cost $35,000.

Boiler and Stoker—Bd. of Trustees, Ohio State University, C. E. Steeb, Secy., Columbus, O., will receive bids until Dec. 22 for a 600 hp. boiler and underfeed stoker. Cost $85,000.

Boilers and Auxiliary Equipment—Lynn Gas & Electric Co., 90 Exchange St., Lynn, Mass., plans to purchase two 1580 hp. boilers and auxiliary equipment for proposed boiler house.

Electric Storage Battery, Motor Generator Charging Set, Switchboard, etc.—Dept. of Public Works, Supplies & Tenders Board, Wellington, N. Z., will receive bids until Feb. 28 for an electric storage battery, including motor generator charging set with necessary control gear and switchboard.

Engine—City of Mansfield, Tex., plans to purchase and install a 129 hp. engine for proposed improvements to electric light plant.

Ice Plant Equipment—Valley Electric & Ice Co., Brownsville, Tex., subsidiary of Central Power & Light Co., Frost Bldg., San Antonio, Tex., plans to purchase machinery and equipment for proposed 50 ton ice plant at San Benito, Tex. Estimated cost $100,000.

Motor—U. S. Engineer, 428 Custom House, St. Louis, Mo., will receive bids until Dec. 14 for a 940 hp. d.c. motor.

Power Equipment—Hesslein & Co., Inc., 75 Worth St., Sand Springs, Okla., c/o C. F. Burney, New York, N. Y., plans to purchase power equipment, etc., for proposed improvements to Queen Esther cotton mill at Sand Springs, Okla. Estimated cost $100,000.

Power Plant Equipment—Penal Institutions Dept., P. A. Chapman, Comr. City Hall, Boston, Mass., will receive bids until Dec. 15 for equipment for proposed power plant at Boston Harbor, Mass.

Pump—City of San Francisco, Calif., plans furnishing and installing sewage pump and appurtenances in Pine Lake Park pumping station.

Pump and Motor—F. G. McFarland, Clk, Sebastopol, Calif., is receiving bids for a pump and motor for operation of new well for city water supply.

Pumping Equipment, etc.—City of Bellville, Tex., plans to purchase pumping equipment, etc., for proposed waterworks imrovements. Estimated cost $55,000.

Pumps—City of Galveston, Tex., is receiving bids for two 750 g.p.m. fire pumps.

Pumps, Etc.—Sewage & Water Board, G. G. Earl, Gen. Supt., New Orleans, La., will receive bids until Jan. 23 for pumps, etc., for river pumping station.

Pumps and Motors—Constructing Quartermaster, Fort Mason, San Francisco, Calif., is receiving bids for two pumps and motors for proposed gasoline and oil storage station.

Testing Machinery — McClintic-Marshall Co., 1242 Book Bldg., Detroit, Mich., plans to purchase a 3,000 lb. testing machine for compression tests.

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